The 2014 Bridge Inspection Manual is replaced by the 2016 Bridge Inspection Manual. The 2014 Bridge Inspection Manual should be used as a historical reference for bridge inspection reports performed using the NYSDOT 1-9 rating system.
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FOREWORD

In order to serve, protect and preserve the health, safety and welfare of the public, New York State requires the comprehensive inspection of all bridges that are publicly owned, operated, or maintained as defined in section 230 of the Highway Law, and that also carry public highway traffic.

This document replaces the *Bridge Inspection Manual – 1997* published in 1997 by the New York State Department of Transportation Office of Structures. This manual explains the requirements for general bridge inspections as required by New York State's Uniform Code of Bridge Inspection, NYCRR PART 165.

RICHARD MARCHIONE, P.E.
DEPUTY CHIEF ENGINEER (STRUCTURES)
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Acknowledgements

This edition of the Bridge Inspection Manual is the result of a collective effort of many people in the NYSDOT Office of Structures, NYSDOT Regional Offices and several consultant inspection firms. In the final stages of the work, the Main Office Bridge Inspection Unit coordinated all technical comments, did several rewrites and the final edit to achieve uniformity in presentation, technical content and writing style.

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Glossary

Acronyms and Definitions

AASHTO - American Association of State Highway and Transportation Officials
ATL – Assistant Team Leader
BIM – Bridge Inspection Manual
BIN – Bridge Identification Number; a unique seven character identifier assigned to bridges in NYS
BIRM – Bridge Inspector’s Reference Manual; an FHWA manual
BISM – Bridge Inspection Safety Manual
CFR – Code of Federal Regulations
DCES – Deputy Chief Engineer (Structures)
DOT – Department of Transportation
EB – Engineering Bulletin
EI – Engineering Instruction

Element – One of many possible ‘Item’ components, for example:

<table>
<thead>
<tr>
<th>Item</th>
<th>Element</th>
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<tbody>
<tr>
<td>Abutment</td>
<td>Joint with Deck</td>
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<td></td>
<td>Bearings</td>
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<td>Bridge Seat &amp; Pedestals</td>
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<td>Backwall</td>
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<td>Stem</td>
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<td>Footings</td>
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<td>Deck</td>
<td>Wearing Surface</td>
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<td>Sidewalks &amp; Fasciae</td>
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FHWA – Federal Highway Administration

Item – One of the several major components that comprise a bridge, for example:

- Stream channel
- Abutment
- Wingwall
- Pier
- Approaches
- Deck
- Superstructure
- Utilities

MBE – Manual for Bridge Evaluation

NBI – National Bridge Inventory

NBIS – National Bridge Inspection Standards

NHI – National Highway Institute

NYS – New York State

OSHA – Occupational Safety and Health Administration

QAE – Quality Assurance Engineer

QCE – Quality Control Engineer

RSME – Regional Structures Management Engineer

Soundings – Water depth readings

SSU – Substructure Unit

TA – Technical Advisory

TL – Team Leader

UCBI – Uniform Code of Bridge Inspection

VIRTIS – Load rating and analysis software used by NYSDOT

WZTC - Work Zone Traffic Control
# TABLE OF CONTENTS

**FOREWORD**

**ACKNOWLEDGEMENTS**

**GLOSSARY**

## CHAPTER 1

### 1 INTRODUCTION

1.1 Types of Inspection  
1.2 Scheduling, Planning and Preparation for Inspection  
1.3 Inspection Team and Inspector Qualifications

## CHAPTER 2

### 2 DOCUMENTATION

2.1 The BIN Folder  
2.2 Bridge Inspection Diary  
2.3 Plan Verification and Update  
2.4 Apparent Violations of Load Postings  
2.5 The Inspection Report  
2.5.1 Condition Ratings  
2.5.2 General Notes  
2.5.3 Condition Comments  
2.5.4 Condition Photographs and Standard Photographs  
2.5.5 Condition Sketches  
2.5.6 Flagging Documentation  
2.5.7 Additional Information

## CHAPTER 3

### 3 SUPPLEMENTAL GUIDANCE

3.1 Bridge Inspection Date & Inspection Time  
3.2 Inventory  
3.3 Bridge Orientation Conventions  
3.4 Vertical Clearance and Load Postings  
3.5 Recommend Further Investigation  
3.6 General Bridge Material Deficiencies

## CHAPTER 4

### 4 STREAM CHANNEL & SUBSTRUCTURE ELEMENTS

#### SECTION A

4A STREAM CHANNEL

- Introduction  
4A.1 Stream Alignment  
4A.2 Erosion and Scour (Stream Channel)  
4A.3 Waterway Opening  
4A.4 Bank Protection
SECTION B  4B  SCOUR, EROSION AND STREAM CHANNEL DOCUMENTATION
-   Introduction
4B.1  Channel Cross-Section at Fascias
4B.2  Channel Profile Near Substructures
4B.3  Substructure Undermining and Erosion
4B.4  Stream Alignment Sketch

SECTION C  4C  ABUTMENTS AND WINGWALLS
4C.1  Abutment Introduction
4C.2  Joint With Deck
4C.3  Bearings, Anchor Bolts & Pads
4C.4  Bridge Seat & Pedestals
4C.5  Backwalls
4C.6  Stem
4C.7  Wingwall Introduction
4C.8  Walls
4C.9  Erosion or Scour
4C.10  Footings
4C.11  Piles
4C.12  Abutment Recommendation
4C.13  Substructure Deficiency Sketch

SECTION D  4D  PIERS
4D.1  Pier Introduction
4D.2  Bearings, Anchor Bolts & Pads
4D.3  Pedestals
4D.4  Top of Pier Cap or Beam
4D.5  Solid Pier Stem
4D.6  Cap Beam
4D.7  Pier Columns
4D.8  Footings
4D.9  Erosion or Scour
4D.10  Piles
4D.11  Pier Recommendation
4D.12  Substructure Deficiency Sketch
CHAPTER 5 5 APPROACHES

5.1 Drainage
5.2 Embankment
5.3 Settlement
5.4 Erosion
5.5 Pavement
5.6 Guide Railing

CHAPTER 6 6 DECK

6.1 Wearing Surface
6.2 Curbs
6.3 Sidewalks and Fascias
6.4 Railings and Parapets
6.5 Scuppers
6.6 Gratings
6.7 Median

CHAPTER 7 7 SUPERSTRUCTURE

7.1 Structural Deck
7.1A Reinforced Concrete
7.1B Timber
7.1C Grating Deck
7.2 Primary Members
7.2A Reinforced Concrete
7.2B Prestressed Concrete
7.2C Steel Multi-Girder
7.2D Two and Three-Girder
7.2E Metal Trusses
7.2F Timber
7.2G Stone Masonry Arches
7.2H Other Bridge Types
7.3 Secondary Members
7.4 Superstructure Paint
7.4A Non-Weathering Steel
7.4B Weathering Steel
7.5 Superstructure Joints
7.6 Superstructure Recommendation

CHAPTER 8 8 BRIDGE SIZE CULVERTS

8.1 What to Rate: The Primary Member
8.2 What to Rate: Other Elements
8.3 Metal Culverts
8.4 Concrete Culverts
<table>
<thead>
<tr>
<th>CHAPTER 9</th>
<th>9 UTILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>Lighting</td>
</tr>
<tr>
<td>9.2</td>
<td>Sign Structures</td>
</tr>
<tr>
<td>9.3</td>
<td>Utilities and Utilities Supports</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>CHAPTER 10</th>
<th>10 GENERAL RECOMMENDATION</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>CHAPTER 11</th>
<th>11 QUALITY CONTROL &amp; QUALITY ASSURANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.1</td>
<td>Quality Control</td>
</tr>
<tr>
<td>11.2</td>
<td>Quality Assurance</td>
</tr>
<tr>
<td>11.3</td>
<td>Field Reviews (and Field Review Form)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>APPENDIXES</th>
<th>A UNIFORM CODE OF BRIDGE INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>INSPECTION FLAGGING PROCEDURE FOR BRIDGES</td>
</tr>
<tr>
<td>C</td>
<td>SPECIAL EMPHASIS INSPECTION REQUIREMENTS</td>
</tr>
<tr>
<td>D</td>
<td>UNDERWATER INSPECTION</td>
</tr>
<tr>
<td>E</td>
<td>movedable bridges</td>
</tr>
<tr>
<td>F</td>
<td>suspension bridges</td>
</tr>
<tr>
<td>G</td>
<td>required tools and equipment</td>
</tr>
<tr>
<td>H</td>
<td>lead paint containment</td>
</tr>
<tr>
<td>I</td>
<td>technical advisories</td>
</tr>
<tr>
<td>J</td>
<td>using the federal scale</td>
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The National Bridge Inspection Standards (NBIS) establishes the regulations for the inspection and evaluation of the Nation’s bridges. The NBIS is defined in the Code of Federal Regulations (23 CFR 650 Subpart C).

The Code of Federal Regulations (23 CFR 650 Subpart C) recommends the use of reference documents such as the American Association of State Highway and Transportation Officials (AASHTO) Guide Manual for Bridge Element Inspection, the AASHTO Manual for Bridge Evaluation (MBE), the Federal Highway Administration’s (FHWA) Bridge Inspector’s Reference Manual (BIRM), and the National Bridge Inventory (NBI) coding guidance document for the inspection and evaluation of the Nation’s bridges.

Incorporating the Federal Regulations, New York State has issued the Uniform Code of Bridge Inspection (UCBI) (see Appendix A) pursuant to Chapter 781 of the Laws of 1988, to establish a program of comprehensive bridge management and inspection within the New York State Department of Transportation (NYSDOT).

This NYSDOT Bridge Inspection Manual (BIM) provides a methodology for performing bridge inspections in New York State which meets or exceeds the requirements of the UCBI. The NYSDOT BIM shall be used when inspecting:

- UCBI mandated bridges.
- Non-mandated bridges in New York State which are routinely inspected.

The data produced by these inspections shall reside in the NYSDOT inspection software system. The NYSDOT Bridge Inspection Program defines a bridge in accordance with the UCBI.

The NYSDOT BIM is applicable to both the general inspections and the diving inspections. Instructions which are unique to diving inspections and fathometer surveys are provided in Appendix D. The NYSDOT BIM also satisfies the “Bridge Diving Inspection Rating Criteria” which is referenced in the UCBI section 165.6.

This manual is not an engineering textbook, nor a primer on fundamentals of bridge inspection. For questions related to material behavior, mechanics, or fundamentals of bridge inspection, consult the latest edition of the BIRM. This manual is a guidance document. Thus, professional judgment and common sense should always dictate actions taken by Professional Engineers during the inspection and evaluation process.

Although applicable NYSDOT Technical Advisories (TA), Engineering Instructions (EI) and Engineering Bulletins (EB) are referenced or incorporated into the text of this manual or provided in the appendices, NYSDOT’s website should be consulted for current and additional issuances. Unless specifically stated, all references in this manual are made to the current version of these documents.
All bridge inspection efforts must adhere to the safety requirements defined in the NYSDOT Bridge Inspection Safety Manual (BISM), NYSDOT Safety Bulletins and Occupational Safety and Health Administration (OSHA) standards, if applicable.

1.1 - Types of Inspection

I. Five types of NYSDOT bridge inspections exist and they are as follows:

1. **General:** General inspections are required for all highway bridges at a maximum interval of 24 months. These inspections encompass both biennial and interim inspections as defined in the Uniform Code of Bridge Inspection (UCBI). Interim inspections are performed during the calendar year between the required biennial inspections, and are required if one or more of the following conditions exist:
   - General recommendation (determined by inspector) of 3 or less.
   - Condition rating (weighted average of individual element ratings) of 3.0 or less.
   - Presence of an active or inactive Red Flag, or active Yellow Flag.
   - Posting for any load other than R-permit restriction.

   Inspection intensity and documentation for the general inspections will be the same regardless of the criteria that triggered the need for the inspection. Scheduling of general inspections will be governed by the requirements that are defined in both the Code of Federal Regulations (CFR) and the UCBI.

2. **Special in-lieu of:** This category of inspections is used for granting and documenting special in-lieu of inspections for bridges that are scheduled for inspection due to the UCBI interim requirements. In no case will a special in-lieu of inspection be granted in back to back inspection seasons. Note that a special in-lieu of inspection requires written approval of the Deputy Chief Engineer (Structures). See the UCBI for specific details regarding special in-lieu of inspections.

3. **Special Events:** Information collected during these inspections does not directly impact the condition ratings of a structure. Use of these type inspections will not follow the normal Quality Control / Quality Assurance workflow that is utilized for general and diving inspections. The information will typically be available in the NYSDOT inspection software system as an attachment that can be reviewed and downloaded:
   a. **Flood Watch:** This sub-category will be utilized to attach summary forms of flood watch inspections.
   b. **Post-Flood Inspection:** This sub-category will be utilized to attach summary forms of post-flood inspections.
   c. **Post-Seismic Event:** This sub-category will be utilized to attach summary forms of post-seismic inspections.
   d. **Impact Assessment:** This sub-category will be utilized to attach summary forms of bridge impact assessments.
e. **Found Structural Flag Repair:** This sub-category will be utilized to summarize the instance when a structural flag repair is found, the structural flag can be removed and there is no other reason to inspect the structure. In such instances, the inspector shall fully document the findings, work with the Region to remove the structural flag and re-designate the type of inspection from general /special-in-lieu of to found structural flag repair.

f. **Other:** This sub-category will be utilized to attach summary forms of other instances of non-scheduled inspection events.

4. **In-Depth Inspection:** This category will be utilized to attach summary forms of bridge in-depth inspections. See the BIRM for a definition of In-Depth.

5. **None Due to Construction (under contract):** This category of inspections is used for bridges that are closed to all traffic due to reconstruction. Note that temporary structures constructed within a work zone to handle staged traffic are the contractor's responsibility and do not get inspected as part of the general bridge inspection program and are, therefore, not covered by this inspection type. Note further that a general inspection must be performed within 60 days of reopening to traffic of the newly constructed bridge or any portion thereof. The inspection must occur after opening to traffic in order to ensure that the inspector can view the structural behavior of the bridge after having experienced live load conditions in all directions. Any portion of an existing bridge that is under contract and carries traffic remains on the inspection schedule.

II. **Four types of NYSDOT bridge diving inspections** exist and they are as follows:

1. **General Diving (commonly referred to as Diving):** General Diving inspections are required at a maximum interval of 60 months. Scheduling of diving inspections will be governed by the requirements that are defined in both the Code of Federal Regulations (CFR) and the UCBI.

2. **Special Events:** This category is reserved for events that are typically not scheduled, where, however, a diving inspection is performed. Information collected during these inspections does not directly impact the scheduling or condition ratings of a structure. Use of these type inspections will not follow the normal Quality Control / Quality Assurance workflow that is utilized for bridge and diving inspections. Information will be able to be added directly by users with privileges to do so in the NYSDOT inspection software system. The information will typically be available as an attachment that can be reviewed and downloaded:
   a. **Flood Watch:** This sub-category will be utilized to attach summary forms of flood watch inspections.
   b. **Post-Flood Inspection:** This sub-category will be utilized to attach summary forms of post-flood inspections.
   c. **Post-Seismic Event:** This sub-category will be utilized to attach summary forms of post-seismic inspections.
   d. **Impact Assessment:** This sub-category will be utilized to attach summary forms of bridge impact assessments.
e. **Found Structural Flag Repair:** This sub-category will be utilized to summarize the instance when a structural flag repair is found, the structural flag can be removed and there is no other reason to inspect the structure. In such instances, the inspector shall fully document the findings, work with the Region to remove the structural flag and re-designate the type of inspection from general to found structural flag repair.

f. **Other:** This sub-category will be utilized to attach summary forms of other instances of non-scheduled inspection events.

3. **In-Depth Inspection:** This category will be utilized to attach summary forms of bridge in-depth inspections. See the BIRM for a definition of In-Depth.

4. **None Due to Construction (under contract):** This category of inspections is used for bridges that are closed to all traffic due to reconstruction. Note that temporary structures constructed within a work zone to handle staged traffic are the contractor's responsibility and do not get inspected as part of the diving inspection program and are, therefore, not covered by this inspection type. Note further that a diving inspection must be performed within 60 days of reopening to traffic of the newly constructed substructure unit (SSU) or any portion thereof. The inspection must occur after opening to traffic in order to ensure that the inspector can view the structural behavior of the SSU after having experienced live load conditions in all directions. Any portion of an existing bridge that is under contract and carries traffic remains on the inspection schedule.

Criteria for qualifying an SSU to receive a diving inspection is defined in UCBI section 165.4 (b).

### 1.2 - Scheduling, Planning and Preparation for Inspection

Scheduling, planning, and preparation for all inspection efforts shall follow the relevant sections in the BIRM.

All scheduling efforts should maximize efficiency between the first and the last day of an inspection. When scheduling work, the project manager must consider the following:

1. Ensure that intervals since the last inspection meet the Intervals of Inspection requirements given above (Chapter 1.1).
2. Maximize efficient use of labor, Work Zone Traffic Control (WZTC) and special access equipment.
3. Minimize need for return visits by scheduling initial visit(s) to stream bridges during low flow.
4. Minimize travel distance between bridges.
5. Successive inspections are not performed by the same inspector.
6. Job Hazard Analysis: although an on-going process, all potential hazards must be identified, evaluated and mitigated. This may effect:
   - The quantity and qualification of inspection teams.
   - The access equipment being used.
   - The inspection methodology including coordination with other involved entities.
   - The Personal Protective Equipment (PPE) being used.
   - The inspection tools being used.
Inspection team planning and preparation measures prior to the field inspection shall include organizing the proper tools and equipment and locating and reviewing bridge structure plans and files. The success of the on-site filed inspection is largely dependent on the effort spent in preparing for the inspection.

### 1.3 - Inspection Team and Inspector Qualifications

A general inspection team consists of a Team Leader (TL) and an Assistant Team Leader (ATL). A diving inspection team consists of a TL and two Divers. Additional personnel may be added to the inspection team based on justifiable circumstances. All field work must be reviewed by a Quality Control Engineer (QCE) whose duties are described in Chapter 11.

The Team Leader is responsible for ensuring that the bridge is inspected and that the inspection report is prepared in conformance with the requirements of this manual. Under the Team Leader’s direct supervision, an Assistant Team Leader may also inspect, measure and document components.

In a diving inspection, the Team Leader typically conducts the inspection through the aid of the in-water diver using audio and visual communication. The other diver remains top-side and manages the diving equipment which supports the in-water diver. When the Team Leader is the in-water diver, the Team Leader will remain responsible for ensuring that the inspection information is transcribed correctly into notes and sketches by one of the top-side divers, during the diving inspection.

All personnel assigned to the project shall meet the minimum educational and experience requirements for their positions as described in Section 165.5 of the Uniform Code of Bridge Inspection and as required by the NBIS. In addition to these requirements:

- The QCE will have a minimum of five (5) years of recent experience in bridge design, bridge inspection, or other bridge engineering related experience which is acceptable to the Department.
- The Fathometer Surveyor will have a minimum of three (3) years of recent experience in conducting fathometer surveys which is acceptable to the Department.
- All field personnel shall satisfy OSHA requirements.
- All field personnel assigned to the project must be physically capable of performing the tasks associated with their positions. All field personnel must be able to work at heights, on ladders, on scaffolding and on aerial lifts, or other bridge inspection access equipment. They must be able to climb, work in confined spaces, and be able to work under adverse weather conditions as required. Divers must be capable of working within the tolerable limits of underwater hazards.
- All QCEs, TLs, ATLs and Divers will have a working knowledge of personal computers in a Windows environment and be fully conversant with the NYSDOT inspection software and related software prior to commencing any inspection work. They must be knowledgeable in the use of digital cameras, scanners, and other hardware necessary for the project.
- All QCEs, TLs, and ATLs will have a working knowledge of VIRTIS prior to commencing any inspection work.
- The Project Manager shall have demonstrated experience successfully managing projects of similar size and scope.
Prior to any inspection work with NYSDOT, QCEs, TLs and Divers are required to successfully complete the NYSDOT Bridge Inspector’s Workshop. Load Rating Engineers (LRE) and ATLs performing NYSDOT inspection work are also required to successfully complete the NYSDOT Bridge Inspector’s Workshop. Although this is a one-time requirement, based on significant changes in the NYSDOT Bridge Inspection Program or a personnel’s prolonged lapse from bridge inspection work, these individuals may have to repeat this requirement.

If a QCE, TL or Diver is unable to attend an available NYSDOT Bridge Inspector’s Workshop, the individual may be temporarily approved to work based on the individual’s successful completion of the two-week National Highway Institute (NHI) Bridge Safety Inspection Course. LREs and ATLs who are unable to attend an available Workshop may be temporarily approved to work on a case-by-case basis. The temporary approval will expire when the next NYSDOT Bridge Inspector’s Workshop is provided.

All relevant personnel should meet the refresher training attendance requirements noted in the NBIS. Additionally, approved QCEs and TLs are to attend the NYSDOT Bridge Inspector’s Meeting annually. Exception to this requirement may be provided by the NYSDOT Main Office Bridge Inspection Unit if extenuating circumstances prevent attendance.
2.1 - The BIN Folder

Every bridge in the state requiring inspection under the Uniform Code of Bridge Inspection must have a folder identified with the bridge identification number (BIN). This folder should be maintained in accordance with the AASHTO Manual for Bridge Evaluation (MBE), Section 2 and contain at a minimum the following items:

- Current and previous inspection reports, inventory, and special emphasis documentation, if required (see Appendix C). Reports over six years old may be removed and archived.
- Plans (rehabilitation, retrofit and "as-built", if available) or sketches in lieu of plans, if plans are not available.
- Paper copies of Level 1 Load Rating Summary sheet and electronic or paper copies of calculations (if available).
- Level II Load Rating Summary Sheet
- Copy of the most recent diving inspections and/or fathometer surveys, if applicable.
- All pertinent correspondence.
- Independent flag correspondence subfolder

The BIN folders for state and local bridges are kept in the Regions. BIN folders for bridges owned by the eleven public authorities which inspect their own bridges, are maintained by the respective authorities. These eleven authorities are:

- Niagara Falls Bridge Commission
- New York State Bridge Authority
- New York State Thruway Authority
- Ogdensburg Bridge and Port Authority
- Port Authority of New York and New Jersey
- New York State Power Authority
- The Seaway International Bridge Corporation
- Thousand Islands Bridge Authority
- MTA Bridges and Tunnels (a.k.a. Triborough Bridge and Tunnel Authority)
- Nassau County Bridge Authority
- Buffalo and Fort Erie Public Bridge Authority
2.2 - Bridge Inspection Diary

Each Team Leader is required to record in a hard copy Bridge Inspection Diary the following information about the inspection team's daily activities:

- Bridge Identification Number (BIN), Substructure Unit (SSU) when applicable, county, feature carried and crossed.
- Time of arrival at the bridge site and time of departure from the bridge site.
- Inspection vehicle mileage.
- For diving inspections and fathometer surveys: starting and ending time for diving or survey.
- Weather conditions.
- Names of all inspection team personnel and their designated titles: TL, ATL, Diver, WZTC, Railroad flagmen etc.
- For each of the personnel, names of the affiliated firm or organization: Region, consultant, subconsultant, subcontractor, etc.
- Description of the inspected area(s) and the type of inspection work.
- Description of traffic control activities such as lane closures (number and duration).
- Description of all equipment used: boom truck, under bridge inspection unit, boat, etc.
- Any noteworthy actions or occurrences: bridge flagged, visitors, motor vehicle accident occurred at the bridge site, personal injury of inspection team member, etc.

When the team is not in the field, a brief general entry should be made describing the activities, BIN specific and other, the inspection team is working on.

The diaries should be kept and maintained throughout the year by the Team Leader.

2.3 - Plan Verification and Update

The inspector must examine the report binder, diving reports, fathometer surveys, and plans or sketches in lieu of plans before every inspection to become familiar with the structure and identify features requiring special attention. If the bridge, approaches, or features crossed were modified, replaced or repaired since the last inspection, plans or sketches must be updated to illustrate current conditions clearly and the inventory items must be verified and updated as necessary. Note these modifications, replacements and repairs with the observation date in the inspection report.

On new state bridges, the as-built plan dimensions may be assumed to have been verified if the job has been accepted by the Engineer in Charge (E.I.C.). This assumption cannot always be made for new local bridges. Plans or sketches in lieu of plans must be dated and initialed by the Team Leader, regardless of modifications. Instead of signing the plans directly, it is acceptable to attach a sheet to the plans or sketches that can be used for Team Leader signature and to show whether changes have occurred since the last inspection.

Sketches in lieu of plans must be prepared if existing plans or sketches are missing, incomplete, or inaccurate. If totally new sketches are needed, they must be drawn in English units and include plan, elevation, and cross-section views with the pertinent dimensions recorded.
2.4 - Apparent Violations of Load Postings

The inspector must note any apparent violations of load postings by any privately or publicly owned vehicle. This should be recorded within the inspection report. If possible, it should include the owner and plate number and estimated weight of each vehicle. For multiple violations by the same vehicle, the number of violations observed should be noted.

2.5 - The Inspection Report

Inspection reports generally consist of:

- Condition Ratings
- General Notes
- Condition Comments
- Condition and Standard Photographs
- Condition Sketches
- Flagging Documentation
- Additional Information

For further information on other forms that must be completed, consult the NYSDOT Bridge Inventory Manual and load rating instructions. All documentation should be completed during the inspection at the bridge site.

2.5.1 - Condition Ratings

Bridges typically contain several or all of the following items: abutments, wingwalls, stream channel, approaches, decks, superstructures, piers, and utilities. Each of these items is made up of ratable elements as described within Chapters 4A thru 9. The scale of 1 through 9, shown below, has been established to objectively rate the bridge elements.

-Scale

The rating definitions are:

- 9 – Condition and/or existence unknown.
- 8 – Not applicable.
- 7 – New condition. No deterioration.
- 6 – Used to shade between ratings of 5 and 7.
- 5 – Minor deterioration, but functioning as originally designed.
- 4 – Used to shade between ratings of 3 and 5.
- 3 – Serious deterioration, or not functioning as originally designed.
- 2 – Used to shade between ratings of 1 and 3.
- 1 – Totally deteriorated, or in failed condition.
This scale is used to rate the condition of the bridge element in comparison to its original design capacity and to its original functioning; this scale shall not be used to rate the condition of the bridge element in comparison to the present-day standards. For example, the rating for a bridge element should not be reduced because its design and configurations are out of compliance with present-day standards. The following elements are exceptions to this requirement: Stream Alignment, Waterway Opening and General Recommendation. Stream Alignment and Waterway Opening are rated on site-specific performance requirements (see Chapter 4, Section A). General Recommendation is the Team Leader’s assessment of the overall bridge condition (see Chapter 10).

It is essential that the inspector uses the rating scale in a manner consistent with the criteria established in this manual. Meaningful statewide assessment of bridge conditions is possible only through consistent use of the rating scale.

Normally, a rating of 9 is used when:

- the rated element is completely concealed from view
- there are no secondary indications of problems
- it is not possible to gain access for inspection

Superstructure elements (primary member, structural deck, secondary member, and paint) may only be rated 9 rarely, such as completely closed vaults or cells with no means of entry. A rating of 9 for any element other than footings must be thoroughly explained in the inspection report.

In determining a numerical rating for a deteriorated element, temporary repairs such as a steel plate over a hole in a deck or shoring to support a deteriorated beam, shall not be considered in the rating determination. The element should be coded as though the temporary repair does not exist. However, presence of a temporary repair shall be documented in the inspection report.

For bridges under stage construction, ratings should consider only those portions open to highway traffic. The portion under construction should generally be ignored in the rating. Element rating notes should clarify which portion is being inspected and how it is being rated. Include a brief bridge level note detailing stage construction conditions and any changes to bridge type.

With exception to the Worst of Multiple Elements listed below, the element rating is representative of the multiple components. For example, the rating of a primary member is not based on the worst girder in a multi-girder span but evaluates all girders including the "worst" girder to derive a representative rating.
-Rating the Worst of Multiple Elements

The following bridge elements are rated on the basis of the condition of the worst component (do not average the conditions of the components):

- Abutment bearings
- Abutment pedestals
- All wingwall elements (per abutment)
- All approach elements (rate worst approach for each element)
- Curbs (rate worst side)
- Stream Channel Bank Protection
- Sidewalks and fascias (rate worst side, rate worst of the two)
- Railings and parapets (rate worst side)
- Pier bearings
- Pier pedestals
- Pier columns
- Lighting standards and fixtures (worst system if multiple systems are present)
- Utilities and utilities supports (worst system if multiple systems are present)

For example, in a row of similar bearings the worst bearing shall be rated; this rating is not necessarily a representative value of all the bearings in that row.

-Use of Diving Inspections and Fathometer Surveys

A general inspection Team Leader shall use a diving inspection report and/or a fathometer survey report, when these reports are available, to issue ratings for the bridge elements which are inaccessible due to the water depth or the velocity of the water. The diving report must never be used to improve the rating the Inspector would have assigned to the bridge absent the diving report. A rating of "9" shall not be used when the diving/fathometer reports available can otherwise provide ratings.

When the diving report and/or the fathometer survey report has been used in developing element ratings, a statement shall be placed in the bridge inspection report referencing the diving/fathometer report. The reference shall include the date of the diving/fathometer report and state that the rating is based in part, on the information presented in that report.

Guidelines and instructions which are unique to the diving inspection and fathometer survey program are provided in Appendix D.

2.5.2 – General Notes

These are general remarks and comments which are applicable to the whole bridge: these are not assigned to a specific element condition rating. General notes are also referred to as "bridge level notes".
2.5.3 – Condition Comments

Condition comments are required:
- for all elements rated 4 or lower
- to explain why any element was uprated from the previous inspection report rating
- for all elements rated 9 except footings and piles
- for unusual 8 ratings
- for any of the following kinds of rating changes:
  - from 8 to 1-7
  - from 1-7 to 8
  - from 9 to 8
  - from 8 to 9
  - from 9 to 1-7
- if newly acquired record plans indicate a previous 8 or 9 rating was not appropriate

Condition comments must include a complete technical description of the location, nature, and extent of the problem, condition and/or reason for the rating change. Include numerical and condition specific descriptions, such as: "15% section loss of bottom flange of girder 1 along the entire length," "delamination over 25% of the beginning left wingwall face," or "like-new footing recently exposed by scour." Comments shall be cross-referenced to photos. Vague or general statements, such as "significant primary member section loss" or "deteriorated concrete" are unacceptable.

When Rating the Worst of Multiple Elements, provide commentary for each element within that element group rated 4 or less.

Besides describing individual elements, written comments should describe aspects of the bridge that cannot be photographed, including (but not limited to):

- Excessive deflection under live load.
- Unusual noises when vehicles are crossing.
- Observations of stream velocity.
- Observations regarding traffic volume.
- Vehicle (tire) impact caused by approach settlement or heave.
- Scour

Inspectors should strive to provide well-written comments using complete sentences, proper grammar and correct spelling.

2.5.4 – Condition Photographs and Standard Photographs

Photographs are classified as either "condition" or "standard". The photographs shall have an accurate date stamp (format: month/day/year) electronically imprinted at time of capture. The photographs shall be reviewed for content, clarity and perspective prior to being placed in the inspection report. Generally, photograph content should not be altered electronically or otherwise. Minor adjustments in exposure and the addition of text, lines or arrows for clarification and emphasis are acceptable.
Condition photographs document deficiencies and must be taken:
- When elements are rated 4 or lower.
- For repaired or new bridge elements.

When identical deficiencies for an element occur at several locations, one typical photo may be taken instead of photographing each location. For example, one overextended or rusted bearing may be photographed and identified as typical of all similarly deficient bearings.

Condition photos shall include a brief description of what is being photographed (e.g.: "Pier 1, column 3 spalling, looking left") and a cross-reference to written comments in the inspection report, if any. Include a photo location plan for all condition photographs in the inspection report. See figure 2.5.4.1 for an example.

Figure 2.5.4.1 – Condition Photo Location Plan
The following standard photographs must be taken of each bridge when it is first completed or as directed below:

<table>
<thead>
<tr>
<th>Description</th>
<th>Digital Image Name</th>
</tr>
</thead>
</table>
| The bridge from each approach, standing about 100 feet from each end of the bridge. All topside deck elements should be visible. When necessary, multiple photos for each approach should be taken, for example: wide bridge or multi-lane obscured by median barrier separation. All posting signs (load restriction, vertical clearance, etc.) shall be readable, otherwise take additional standard photos as necessary. | ApproachBegin.jpg  
|                                                                              | ApproachEnd.jpg    |
| Elevation views showing the general structural configuration of each side of the bridge, and if possible, taken from a 90-degree angle to the centerline of the bridge. All vertical clearance signs shall be readable, otherwise take additional standard photos as necessary. | Elevation{Face}{Span #}.jpg 
|                                                                              | e.g.: ElevationLeftSpan1.jpg |
| Deck underside showing each different type of underdeck structural system. Take a separate photo of the structural deck, if it is not visible in the first underside shot. | Framing{Span #}.jpg  
|                                                                              | e.g.: FramingSpan2.jpg |
| Elevation view of each type of abutment and wingwall.                       | Abutment{Begin or End}.jpg  
|                                                                              | e.g.: AbutmentBegin.jpg |
| Elevation view of each type of pier.                                        | Pier{pier #}.jpg  
|                                                                              | e.g.: Pier3.jpg |
| Any individual posting or unusual components or details, including (but not limited to) dolphins, fenders, moveable bridge components, wingwalls and unusual weld details. | {detail}.jpg  
|                                                                              | e.g.: FenderPier2.jpg |
| Features under the bridge (streams, highways, etc.) as seen from both fascias. | Feature#CrossedSpan#Left.jpg  
|                                                                              | Feature#CrossedSpan#Right.jpg  
|                                                                              | e.g.: F2CrossedSpan3Right.jpg |

Standard photographs shall be replaced:

- Every 6 years or
- if change conditions (e.g.: major deck repair or deck replacement, railing replacement, full superstructure repainting, major change in stream alignment or bank protection, etc.) noted in the field require a new standard photo for a particular location, then all of the standard photos shall be replaced (exception: new posting signs do not require all new Standard Photos).

The Regional Structures Management Engineer may grant a waiver to standard photograph replacement for large, complicated or difficult-to-photograph bridges.
2.5.5 - Condition Sketches

Condition sketches are required whenever element conditions cannot be documented completely with photographs and written comments. Such situations include (but are not limited to):

- Scour and undermining.
- Delaminations, spalls, and hollow-sounding areas of concrete elements.
- Bearing over-extension or under-extension.
- Impact damage to primary members, including protective devices such as fenders and dolphins.
- Tilting abutments or wingwalls.
- Plan view of poorly aligned stream channel.
- Primary member section loss
- Deck deficiencies

Condition sketches must be drawn neatly and clearly with all pertinent dimensions recorded. Condition sketches should be produced in an electronic format to facilitate and simplify edits/updates during subsequent reports. The electronic format must be compatible with the NYSDOT inspection software. It is acceptable to digitally scan hand sketches from previous reports and update them for the current report, as long as the updated sketch remains clear and legible.

2.5.6 – Flagging Documentation

Bridge flags are stand alone documents issued to provide timely notification of critical inspection findings to responsible parties. Flags shall contain all information necessary to thoroughly document and locate flagged deficiencies including (but not limited to) a written description, measurements, calculations, detail and location sketches, and photos.

For additional information regarding bridge flags, see Appendix B “The Inspection Flagging Procedure for Bridges”.

2.5.7 – Additional Information

In addition to general notes, condition ratings, condition comments, photographs, sketches and flagging documentation, inspection reports may contain and require addressing some or all of the following information:

- Overall Condition
  - General Recommendation
  - Computed Condition Rating
- Problems Requiring Further Action (Recommended Further Investigation, see Chapter 3)
- Postings
- Overload Observations
- Federal Ratings
- Diving Inspection Needs
- Inventory Problems
• Miscellaneous
• Special Emphasis Inspection Requirements
• Notes to Next Inspector
  o Unique access requirements may exist at a bridge site. In such cases, inspectors should record appropriate access guidance within the ‘notes to the next inspector’. These notes may include special coordination procedures (Coast Guard, security, operations personnel, contact and phone number, certification requirements, etc.), safety concerns (rattlesnakes, bats, presence of homeless persons or belongings, poison ivy, giant hogweed, etc.), and optimum periods of the year to inspect the bridge (lake draw down, canal dry time, snow, ice, bird nesting seasons, etc.).

• Improvements Observed
• Personnel Present During Inspection
CHAPTER 3
SUPPLEMENTAL GUIDANCE

3.1 – Bridge Inspection Date & Inspection Time

Bridge inspections are often performed over the course of several days. Dates and times for each field inspection must be entered into the inspection report specific to that bridge. If the inspection took more than one day, the bridge inspection date is the last day that the inspection team was in the field. Other documentation in the inspection report, such as remarks, photos, sketches, scour documentation, etc., should show dates that reflect when that part of the work occurred.

Total bridge inspection hours should include the approximate time required for the inspection team to complete all inspection tasks, including travel, access, inspection, inventory, report preparation and submission associated with the bridge.

Occasionally, after submission of a completed inspection report, the QCE or Quality Assurance Engineer (QAE) may request a follow-up visit to the bridge. For such instances, where minor revision to the inspection report is required, the bridge inspection date (last day in the field) should not be modified to reflect the follow-up visit and a note shall be provided indicating the reason for the date discrepancy. For example: if QCE or QAE requests a follow-up visit for additional condition photos, place a note in the report explaining why the photo date and last day in field date do not match but do not change the bridge inspection date. For significant revisions, additional guidance regarding the bridge inspection date may be obtained by contacting the Regional Structures Management Engineer. An example of a significant revision is when the QCE or QAE requests section loss measurements of a primary member.

3.2 – Inventory

Generally, the NYSDOT inspection software system will contain the required inventory items prior to an inspection. When the information for a required inventory item is not shown or is incorrect, the inspection Team Leader shall complete this information in accordance with the NYSDOT Bridge Inventory Manual.

3.3 – Bridge Orientation Conventions

Directions, stationings, and stringer numbering should be made relative to the direction of orientation of the bridge. The direction of orientation is an inventory item available in the NYSDOT inspection software system. Looking across the bridge in the direction of orientation, a two-girder bridge, for example, would have a left and a right girder; a multi girder bridge would have girders starting with #1 at the left fascia. Stationings for measurements, such as channel cross-sections or profiles, should increase in the direction of orientation or from left to right when looking in the direction of orientation. To maintain a historical trend, an exception should be considered when a different convention has been used in previous inspections for rating the various bridge elements.

For more information on direction of orientation, see the NYSDOT Bridge Inventory Manual.
3.4 - Vertical Clearance and Load Postings

Vertical Clearance and Load Posting entries show whether the inventory database has a record of these signs either on or under the bridge. These are not entered during the time of inspection unless the current information is incorrect or absent. All existing vertical posting information is recorded in feet and inches. All load posting information is recorded in U.S. tons. U.S. Customary units are currently being used for load postings and vertical clearance.

Existing inventory information will be available in the database for inspectors to review at the time of the inspection. If the existing information is consistent with conditions encountered in the field, no update is necessary. If the existing inventory shows that the bridge is not posted, but the bridge is actually posted for clearance or load, the existing inventory postings must be updated. When no existing inventory posting information is given, such as for a new bridge, enter values for these items based on observations and measurements made in the field.

Vertical Clearance:

If the vertical clearance in the field varies from the existing inventory information, the clearance value must be updated. If the existing inventory information shows that the bridge is posted for clearance, but no signs are present, consult the Flagging Procedure (Appendix B) for further guidance.

Any differences from the existing inventory’s vertical clearance values must be verified by measuring clearance in the field. Measure the vertical clearance, to the nearest 1 inch (rounded down), between the lowest permanent, overhead obstruction and a point on the travel lane which is directly below it (not including shoulders). A bridge intersecting a highway is posted for clearance if the actual measured minimum clearance is less than 14 feet. If posting for vertical clearance is necessary, a bridge is posted for 1 foot less than the actual measured minimum vertical clearance. If the legend on the posting sign does not meet this requirement, refer to the Flagging Procedure.

For bridges with railroad vertical clearance 25 feet or less, direct field measurements shall be made to determine the smallest vertical dimension between the top of each rail of each track and the underside of the above structure. These measurements shall be taken at a minimum of every 6 years or when any new work on either the bridge or the rails affects the previous measurements. If the vertical clearance is greater than 25 feet, a general bridge note shall be placed in the inspection report indicating “Railroad vertical clearance greater than 25 feet therefore no direct field measurement required.”

A simple line sketch with accompanying table shall be prepared to record the minimum vertical clearances over the railroads. The sketch shall show a plan view of the bridge and/or spans and locate all railroad tracks in relation to the bridge. The sketch shall also show the approximate location (point) of each minimum vertical clearance measurement being recorded. These points shall be numbered in ascending order and recorded in the table with the corresponding minimum vertical measurement. The following descriptive information shall also be provided on each sketch:

- BIN
- Feature Carried
- Features Crossed
- North Arrow
Labeling of bridge elements based on inspection orientation
Prepared by:
Date:
The sketch shall be kept in the BIN folder. When new measurements are documented, note this in the bridge inspection report and update the inventory accordingly.

Load Posting:

If a load posting is less than the existing inventory value, enter the new lower value. If a new load posting is greater than the existing inventory value, review the BIN folder to determine if the posting was raised for sound technical reasons. If so, explain this in the "Remarks" section and inventory the new, higher value. If review of the folder suggests no sound technical reason for raising the posting, do not update the inventory, but immediately consult the Flagging Procedure (Appendix B) for further guidance.

If inventory information indicates that the bridge is posted for load, but no posting signs are found, review the BIN folder. If the bridge has been replaced and NYS Professional Engineer-signed documents show that the new bridge was designed for legal loads, update the inventory to indicate that no posting is required. Similarly, if the bridge was rehabilitated and the NYS Professional Engineer-signed documents indicate the load capacity is increased to allow for legal loads, update the inventory value accordingly. However, if the bridge should still be posted but signs are missing, do not inventory this item and immediately consult the Flagging Procedure (Appendix B) for further guidance.

For bridges closed temporarily for reconstruction, do not code this item. For additional load posting guidance and load posting guidance on closed bridges see the NYSDOT Bridge Inventory Manual.

3.5 - Recommend Further Investigation

Recommend further investigation to suggest the need for further engineering investigation or analysis. Recommending further investigation brings bridges, which might require further action, to the attention of the Regional Structures Management Engineer and/or bridge owner. This is intended to help the Region and/or the bridge owner avoid the possibility of no action due to oversight but is not meant to serve as notification for matters requiring immediate action. Do not use this space to show need for repair work; condition ratings and comments will do that. If any of the following conditions exist then recommend “Further Investigation”.

- Calculations are needed to evaluate structural significance of a particular observation. For example, deterioration may be progressing rapidly on the primary members of a bridge not posted for load. Recommend “Further Investigation” and indicate "Evaluate for load posting" under "Remarks."

- The scope of inspection being performed is insufficient to evaluate structural significance of a potentially serious condition. For example, one may be inspecting a steel bridge where the primary members are encased in concrete, which show evidence of heavy leakage with rust stains. The primary members should be rated based on what is visible, the limitation of the rating should be explained, and “Further Investigation” recommended with a comment added recommending removal of the encasement.
For the National Bridge Inspection (NBI) Substructure Condition rating, the Team Leader must consider scour as well as the physical condition of the substructure. If the Scour Critical Rating is 2 but there is no evidence of scour at the substructures, or if the Scour Critical Rating is 8 and there is evidence of scour at the substructures, then recommend “Further Investigation” by the Regional Hydraulics Engineer. It is also recommended that the hydraulic vulnerabilities (HVA) form be completed.

Additional examples for recommendation of “Further Investigation” can be:
- Pin and hangers should receive non-destructive testing
- Level 1 Load rating needed
- Determine height of footing
- Determine existence of piles
- Core underside of arches to determine strength
- Core deck to determine strength
- Deck evaluation needed due to widespread cracking
- Exposure of significant number of piles with unknown foundation information such as pile-tip elevation.
- Etc...

These examples are cases where it is appropriate to call for further investigation. That is a matter of judgment by the Team Leader. When “Further Investigation” is recommended an explanation is required.

Actions taken and findings due to recommended “Further Investigation” should be recorded in the BIN folder by the RSME, bridge owner or their designee.

3.6 – General Bridge Material Deficiencies

Bridges are typically constructed from a possible combination of concrete, masonry, steel or timber. Irrespective of what bridge element these materials are used for, they should generally be inspected for the following:

**Concrete** (plain, reinforced, and prestressed):
Look for cracking, scaling, spalling, chemical attack and damage due to external forces such as collision damage or ice forces.
- Cracking: note the length, width, location, orientation, differential movement and presence of stains (rust, efflorescence).
- Scaling – gradual loss of surface mortar: note the location and dimensions of the area, condition of the exposed reinforcement (number, spacing, section loss) and depth of penetration indicating the loss of material. Use the BIRM’s definitions for scale ranging from light to severe.
- Spalling – loss of concrete surface due to reinforcement corrosion: note the location and dimensions of the area, condition of the exposed reinforcement (number, spacing, section loss) and depth of penetration indicating the loss of material.
- Chemical attack, leaching – chlorides, sulphates, etc.: this may appear as spalling, reinforcement corrosion, map-cracking and scaling.
- Damage due to external forces – collision, heat damage, ice flows, etc.: document the extent of damage and identify the source when possible.
Masonry:
Look for displaced, cracked, missing or loose stones and, loss of joint material: note the type and extent of damage. Some of the causes may be similar to concrete damage.

Steel:
Look for corrosion, cracks, condition of connections, distortion, embedment loss and damage due to external forces.
- Corrosion – section loss, crevice corrosion, pitting
- Cracks – fatigue induced
- Distortion – out-of-plane bending
- Connections – rivets, bolts, welds. Protective devices may use steel components which would need assessment: dolphins, fenders.
- Embedment loss – soldier piles, sheet-piling: loss of fill, movement of the piles, movement of embankment and approach roadway.
- Damage due to external forces – collision, heat damage, ice flows, etc.: document the extent of damage and identify the source when possible.

Timber:
Look for deflection, decay, abrasion, condition of connections and damage due to external forces.
- Decay – Insect infestation, fungus, ultraviolet light
- Cracks – stress induced
- Distortion – bowing, twisting or crushing
- Connections – Dowels, bolts, metal spikes and or brackets missing or corroded. Protective devices may use steel components which would need assessment: dolphins, fenders.
- Embedment loss – loss of fill, movement of the piles, movement of embankment and approach roadway.
- Damage due to external forces – collision, fire damage, ice flows, etc.: document the extent of damage and identify the source when possible.

Note that the above conditions are not inclusive of all possible material and element deficiencies. Additional element specific rating and inspection guidance is provided within this manual. For further guidance regarding materials not addressed within this manual, contact the RSME.
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CHAPTER 4
STREAM CHANNEL AND SUBSTRUCTURE ELEMENTS

SECTION A – STREAM CHANNEL
SECTION B – SCOUR, EROSION AND STREAM CHANNEL DOCUMENTATION
SECTION C – ABUTMENTS AND WINGWALLS
SECTION D – PIERS
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This section includes the following rating elements:

4A.1 - STREAM ALIGNMENT
4A.2 - EROSION AND SCOUR
4A.3 - WATERWAY OPENING
4A.4 - BANK PROTECTION

Introduction

The stream channel is the most dynamic system affecting the condition of bridges. The majority of all bridge failures result from hydraulic forces produced by the stream channel. Geomorphic features of a stream can change dramatically during the life of a bridge. These features include changes in channel location, shape, and elevation. Significant changes may also occur in a very short time due to major floods.

The terms erosion and scour are at times used interchangeably, but at other times have notably different meanings. The BIRM defines:

Erosion - Wearing away of soil by flowing water not associated with a channel.

Scour - Removal of a streambed or bank area by stream flow; erosion of streambed or bank material due to flowing water; often considered as being localized around piers and abutments of bridges.

In the discussion about the stream environment below, no significant distinction between stream erosion and scour is made. Some engineers, however, commonly refer to stream erosion as the general lowering of the stream bed and scour as a more localized phenomenon. Later in this chapter, a distinction is drawn between erosion and scour as they pertain to substructures.

In several ways, the channel can change and thus jeopardize stability and safety of a bridge. Bank and channel erosion can cause a lateral shift of the stream. The resulting realignment can undermine piers, abutments, and wingwalls. Channel aggradation (deposition of sediment) reduces the waterway opening and increases stream velocity through a bridge. Flood waters attack and undermine substructures, roadway embankments, and floodplain areas. The channel can degrade (erode) so that bed elevations are lower, undermining the foundation of piers and abutments.
When inspecting the stream channel and the bridge foundations, it is helpful to understand the three types of scour:

- **General scour** is the degradation of the streambed along some considerable length of the river, stream, etc. General scour of the streambed may result from the natural erosion and downcutting process that flowing bodies of water cause over time. It may be accelerated by natural cutoffs in a meandering river that steepen the channel gradient, thus increasing the flow velocity, and therefore, causing scour. Also, contributing to the acceleration of scour are various types of development or manmade modification, such as dam construction, dredging, straightening or narrowing of the channel, etc. Since general scour involves degradation of the channel bed along some considerable distance of channel, major facilities are sometimes used to control scour. These may include a series of drop structures (small dam-like structures) or other scour minimizing construction in the riverbed. Their presence may indicate that the channel is experiencing scour.

- **Contraction scour** results from accelerating flow due to narrowing of channel width. This could be natural, manmade, or both. Comparing width of the bridge opening to width of the river upstream and downstream from the bridge can give a good indication of the likelihood of contraction scour.

- **Local scour** is the lowering of streambed material adjoining the abutments, wingwalls, and around piers because of the abutment, wingwall, or pier obstructing flow. These obstructions accelerate flow and create turbulence that removes sedimentary particles surrounding them. Generally, depths resulting from local scour are much larger than those from general scour. Bridges in tidal locations are particularly vulnerable to local scour due to the imbalance between transport rates of input and output sediment.

The stream channel should be observed at least 250 feet from each fascia to determine each element's rating. If any stream channel element is rated 4 or less for a state bridge, the appropriate NYSDOT Regional Hydraulic Engineer should be notified. Means of notification include, but are not limited to, requesting Further Investigation and submission of a Hydraulic Vulnerability Assessment (HVA) form.

Any deficiencies in the stream channel that cannot adequately be shown in photos should be sketched in a simple plan view. The sketch should show the bridge layout, scour protection measures such as riprap or concrete aprons, stream alignment relative to the bridge opening and locations of debris, siltation, scour pockets, and loss of bank protection. A condition photograph should be taken to emphasize a deficiency or attribute. See also Chapter 4, Section B.
4A.1 - STREAM ALIGNMENT

What to Rate

Rate the alignment of the stream channel at the bridge site in terms of skew angle where the stream approaches the bridge substructure. The scale used for rating stream alignment evaluates the alignment in terms of the approach to and flow through the substructure(s). The alignment is not evaluated in comparison to the original design. Scour and siltation problems can be an indication of poor stream alignment and should be considered accordingly.

What to Look For

Check the stream skew angle as it approaches the bridge substructure. Consider both normal and flood flows. The flow should pass through the waterway opening parallel to the faces of the piers and abutments. Check for shifts in the direction of flow from previous inspections and from original plans. Note any change in direction of approach of a stream to a bridge and any change in the angle where the stream hits the substructure.

Rating Examples

7 - The stream approaches and flows through the waterway opening parallel to the faces of the piers and abutments.

5 - The stream approaches and flows through the waterway opening in a direction other than parallel, but with no evidence of scour, siltation, or other problems caused by this alignment.

3 - The stream approaches and flows through the waterway opening in a direction other than parallel, and flow may be hitting the substructure. There is evidence of scour, siltation, or other problems caused by alignment.

1 - The stream approaches and flows through the waterway opening in a direction other than parallel and flow may be hitting the substructure. The foundation is significantly undermined.
Figure 4A.1.1 - Rate 7
The stream approaches and flows through the opening parallel to the abutment faces.

Figure 4A.1.2 - Rate 5
The stream meanders toward and flows along the left abutment. Scour is not evident.
Figure 4A.1.3 - Rate 3
The stream channel flows parallel to the roadway then turns 90 degrees before the bridge opening. The current alignment contributes to stream bank erosion and exposure of the wingwall footing.

Figure 4A.1.4 - Rate 1
A large deposit of stone and sand has redirected the water to flow along the left stream bank resulting in bank protection failure, substantial bank erosion and significant undermining of the abutment and wingwall footings.
4A.2 - EROSION AND SCOUR  
(Stream Channel)

What to Rate

Rate the erosion and scour of channel banks and streambed. This is not a rating of local scour of the material at substructure footings. That scour is rated under the appropriate pier, wingwall, or abutment item. If general stream channel degradation is occurring and is also causing loss of material at foundations, both the stream channel erosion and scour and substructure erosion or scour should be rated low.

What to Look For

Check for cutting of channel banks and exposed root systems of bank vegetation. Check for changes in channel dimensions. Look for manmade disturbances, such as gravel mining, land development (urbanization), etc. These actions may increase velocities and potential erosion. Compare new stream channel documentation with previous records. Check for undermining or vertical exposure of inlet/outlet aprons.

Consider how fast the observed erosion or scour is occurring. The more rapid the rate of erosion, the lower the rating should be.

Rating Examples

7 - There are no indications of erosion or scour.

5 - Minor erosion or scour is occurring at banks away from the bridge, but is not causing problems at the bridge. This rating would also be used when general streambed degradation (not affecting the bridge) has occurred over decades.

3 - Erosion and scour of the banks is beginning to encroach upon the bridge, with potential for serious problems, especially during flood conditions. Also, for general channel degradation, substructure foundations are being exposed and the erosion has occurred over a period of less than ten years.

1 - Major loss of material in the channel banks or streambed, including loss of material behind wingwalls and at the roadway embankment. For general degradation, the foundations are exposed and possibly undermined and the loss has occurred over a period of three years or less.
Figure 4A.2.1 - Rate 7
The upstream channel is stable. Stream banks are stable with vegetation and not undercut.

Figure 4A.2.2 - Rate 5
The stream has begun to undercut the bank vegetation and some embankment sloughing has occurred.
Figure 4A.2.3 - Rate 4
Stream banks exhibit exposed raw earth and tree roots at all four corners. A scour hole is visible adjacent the right abutment stem.

Figure 4A.2.4 - Rate 3
The bank has eroded to the bridge. Further erosion could threaten the roadway.
Figure 4A.2.5 - Rate 3
Bank erosion is evident by exposure of tree roots. General degradation of the streambed has exposed and caused undermining of the culvert apron and wingwall footings.

Figure 4A.2.6 - Rate 1
The bank and streambed are severely eroded, exposing and undermining the abutment and wingwall footings. Erosion extends behind the wingwall, threatening the roadway.
What to Rate

Rate the adequacy of the waterway opening at the bridge. Consider the extent to which the opening is a hydraulic constriction. This may be caused by siltation and debris or vegetation buildup in the channel upstream from the bridge, or any change in height of the waterway opening at the bridge. The waterway opening may be a hydraulic constriction for the stream if the location of abutments, piers, or scour protection is such that the opening is insufficient for high flow conditions. This may be the case even if stream alignment is good and there is no stream aggradation. The waterway opening is not evaluated on a comparison to the original design. When there is evidence of flooding, such as high-water marks or debris, note the estimated high-water depth.

What to Look For

In assessing the waterway opening:

- Check for accumulation of sediments (sand or gravel) in the channel that may occur at the inside of bends or where velocity decreases.
- Check for buildup of debris and/or vegetative growth in the channel that may restrict flow and increase velocities through the opening.
- Compare the opening at the bridge with previous inspections.
- Check for man-made flow restrictions such as fences that can catch debris during storms.
- Check long term aggradation of the streambed by comparing it with previous inspections and with elevations on the record plans.
- Check for scour near substructures.
- Check for flood deposited debris on bridge seats or lodged in the superstructure, or lodged in trees or stone slope protection upstream or downstream at an elevation suggesting that the bridge opening was full.
- Check for evidence of deck overtopping.
- When feasible, inquire with local residents for bridge specific observations made during periods of heavy rain and flood conditions.

Rating Examples

7 - No change in streambed elevation (aggradation) and no evidence of restrictions.

5 - A minor siltation that has not yet caused any local scour problems at the bridge. There may be long term aggradation of the streambed that has occurred over decades.

3 - Heavy siltation and/or vegetation growth is restricting flow and/or scour pockets are forming near the substructures. Evidence from flood debris indicates opening has been full or in pressure flow.

1 - Debris, heavy siltation and/or vegetation growth is severely restricting the opening and/or scour has exposed or undermined foundations of the piers and abutments. Bridge deck and/or approach roadway regularly overtopped during high water.
Figure 4A.3.1 - Rate 7
There is no change in streambed elevation and no evidence of restrictions.

Figure 4A.3.2 - Rate 5
Long term aggradation at the right abutment has reduced the hydraulic opening and redirected stream flow toward the intact, left abutment embankment. No scour is present and the footings are not exposed.
Figure 4A.3.3 - Rate 4
Long term aggradation results in flow under only the end span and full length exposure of the end abutment footing. No undermining is present.

Figure 4A.3.4 - Rate 3
Inadequate waterway opening is evident by debris caught between the girders. High water flow hits superstructure.
Figure 4A.3.5 - Rate 3
Heavy siltation and vegetative growth nearly fills one span. Flow though the open span has caused scour at the pier and abutment, exposing the footings.

Figure 4A.3.6- Rate 1
Debris caught below the structure, heavy siltation and vegetative growth have reduced the waterway opening capacity. The bridge is regularly overtopped during heavy flow.
4A.4 - BANK PROTECTION

What to Rate

Rate the condition of the worst of the protective material on either side of the channel banks and/or streambed. Do not average the conditions of the protective materials.

What to Look For

Check for displaced material. Look downstream and on the banks for the displaced material. Check for erosion of underlying material. Look for slumping of material indicating movement at the toe of slope. Check any change in slope of the protection. Check joints of sheet piling. Check integrity of wire in gabions. Compare existing protection with previous inspections and as-built record plans.

Rating Examples

7 - Protection is functioning as designed with no movement.

5 - Some minor movement in channel and streambed protection, but not at the substructures. Movement is not causing problems at the bridge.

3 - Major movement in channel and streambed protection that adversely affects the bridge. Any movement of protection at the substructure.

1 - Failure and loss of channel and streambed protection endangering the bridge, roadway embankment, and/or top of the channel banks. Movement of protection at the substructure exposing and/or undermining the foundation of piers and abutments.
Figure 4A.4.1 - Rate 7
The bank protection is functioning as designed with no movement of material.

Figure 4A.4.2 - Rate 5
At left, the bank protection has sloughed into the channel without affecting the bridge.
Figure 4A.4.3 - Rate 4
The lower gabion baskets are significantly tilted towards the stream with the lower portion of the baskets beginning to rust. Stones remain inside cage.

Figure 4A.4.4 - Rate 3
Major movement of bank protection resulted in displaced footing cover. The footing is now exposed.
Figure 4A.4.5 - Rate 2
The bank protection is sloughed and washed away along the channel and abutment exposing the footing and back of the wingwall.

Figure 4A.4.6 - Rate 1
Mechanically stabilized earth wall bank protection failure has resulted in embankment collapse which threatens the roadway.
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The following information must be documented for stream channel and scour conditions (when applicable) at the bridge:

4B.1 - CHANNEL CROSS-SECTION AT FASCIAS
4B.2 - CHANNEL PROFILE NEAR SUBSTRUCTURES
4B.3 - SUBSTRUCTURE UNDERMINING AND EROSION
4B.4 - STREAM ALIGNMENT SKETCH

Introduction

Generally, stream channel cross-section at fascias and channel profiles near substructures must be documented at least every two years at bridges over water, and also when erosion problems are identified at bridges over other features (see Chapter 4, Section A for definitions of stream erosion and scour, and Chapter 4, Sections C & D for definitions of erosion and scour at substructures).

Not all documentation is required at every bridge. Examples include bridges crossing gorges where the stream channel is remote from any part of the bridge, and river crossings with deep and/or swift water. The Team Leader must use sound engineering judgment when any documentation is omitted.

When the features limiting the documentation are permanent, the reason shall be stated in the inspection report’s general bridge notes. When the limiting feature is a singular event, the reason no new readings were taken shall be stated in a note linked to the rating and the most recent documentation shall be attached.

For bridges which normally receive diving inspections, the Team Leader should, in conjunction with the diving report, evaluate the current stream channel and scour conditions. If significant changes are detected, the NYSDOT Regional Hydraulics Engineer should be notified. The Regional Hydraulics Engineer can decide the need for an immediate diving inspection or a change in diving inspection frequency.

4B.1 - CHANNEL CROSS-SECTION AT FASCIAS

Purpose

The purpose for collecting these measurements, also known as dropline readings, is to document changes in the waterway opening at the bridge fascias. Measurements from successive inspections may reveal a trend of lateral stream migration which helps identify any scour problems before they endanger the bridge.
What to Document

Document:

- The streambed relative to fixed points along the bridge fascias.
- The water level relative to a fixed point on the bridge.
- If dropline readings indicate scour holes.

At some locations, channel cross-section readings at the fascias may be reduced or eliminated as directed by the RSME. Examples where this may occur include, but are not limited to:

- Median side fascia readings on parallel interstate type bridges.
- Fascias above non-scourable shale stream beds.

How to Document

Take dropline readings along each fascia of all floodplain spans. Take readings along each fascia, starting at the first substructure before the floodplain and proceeding with spacing not to exceed 10 feet increments to the substructure beyond the floodplain. For short span bridges, consider reducing this to 5 feet increments. A minimum of 4 readings will be taken along each fascia. Consider taking dropline readings at railing post locations if the spacing does not exceed 10 feet. If readings were previously taken, new readings should be taken at the same locations and referenced to the same fixed portion of the bridge. Dropline readings should be measured to a reference datum line on the bridge that is not likely to change with time. For example, the top of the bottom chord of a truss is a better choice than top of railing because of possible railing replacement. If the top of railing is used, be sure to measure the railing height relative to a more permanent reference line such as bottom of sidewalk or deck. If accurate readings cannot be taken because of physical conditions at the site, they can be omitted. Document the reason in the inspection report.

The inspection report shall include a channel cross-section reference sketch showing:

- Partial transverse section identifying the reference datum, water level, and streambed. If the top of railing is used as a datum, show the railing height.
- Plan location of the measurement taken from the datum to the water level. This measurement should be taken where the water depth typifies the stream depth at the bridge at the time of inspection.
- Plan layout of dropline reading locations. Show the direction of stream flow, a North arrow, and label the abutments and piers.
- Significant observations should be included in the Notes table.
- Tabulated dropline readings.

See figures 4B.1.1 and 4B.1.2 for sample channel cross-section documentation.
Scour, Erosion and Stream Channel Documentation

CHANNEL CROSS-SECTIONS ALONG FASCIA'S (feet)

REFERENCE | YEAR | NOTES:
--- | --- | ---
Guide Rail Post | 2009 | \( \checkmark \) Taken @ Post \#24 = 7.8 \text{ ft} \)
Deck | 2011 | \( \checkmark \) Taken @ Post \#17 = 8.2 \text{ ft} \)
\( \checkmark \) Water level | 2013 | \( \checkmark \) Taken @ Post \#9 = 8.0 \text{ ft} \)

SAMPLE
CHANNEL CROSS-SECTION DOCUMENTATION
Figure 4B.1.1
### CHANNEL CROSS-SECTION READINGS:

<table>
<thead>
<tr>
<th>STA.</th>
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<th>STA.</th>
<th>RIGHT SIDE READINGS:</th>
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</tbody>
</table>

**SAMPLE**

CHANNEL CROSS-SECTION DOCUMENTATION

Figure 4B.1.2
4B.2 - CHANNEL PROFILE NEAR SUBSTRUCTURES

Purpose

The purpose for collecting this information is to document the streambed profile at each affected substructure. Readings from successive inspections are intended to help determine if the streambed is either aggrading or degrading which will contribute to scour assessment and the determination of ratings at the substructures.

What to Document

Channel profiles near substructures are required for diving inspections. They are required for bridge inspections whenever the depth or turbidity of the water preclude an adequate visual inspection of the stream bottom next to the substructure. Document the streambed profile relative to fixed points (datum) on the substructure; such as top of footing, bridge seat or top of pier cap. Where this cannot be done, as with concrete culverts, document relative to a fixed reference, such as bottom of slab. If a rod can be used, note also the depth of penetration into the streambed. Sketch any stone protection, showing dimensions.

How to Document

Take readings along the face of the substructure at 5 feet increments and extending up to 25 feet, if necessary, beyond each end of the substructure. If the footing is exposed, readings should be next to the footing; if not, then about 1 foot from the face of the substructure. All readings should be referenced to a datum. If possible, link this datum to the datum used for fascia dropline readings.

Using a probing tool such as a steel rod, check for soft areas in the streambed along the substructures, recording the depth of penetration. Probing might indicate the in-filling of a possible scour hole or the streambed susceptibility to scour. These measurements should be taken at increments not to exceed 10 feet along the substructure length: a minimum of two measurements. If the streambed is rock, stone or similar, penetration documentation is not required.

For diving inspections, see appendix D for additional requirements.

Sketches for channel profile near substructure should show:
- Plan-view of the substructure showing locations of the measurements, the estimated velocity and direction of stream flow, a North arrow and any protective measures such as fenders or dolphins.
- Elevation-view showing the datum and the water surface either as an elevation or as a distance.
- Measurements in a tabular form:
  - The first columns should represent the locations.
  - Each column thereafter should represent the measurements for the given year.
  - The final column should represent the change in values between the current and the previous channel profile measurements: positive (+) values indicate aggradation, negative (-) values indicate scour.
- Type and extent of scour protection.
- Early indications of scour, including any loss of scour protection.
Water surface elevation and time of reading for tidal waters.
Changes that have occurred since the previous inspection should be noted on the sketch.

See figures 4B.2.1 and 4B.3.1 for sample channel profile near substructures documentation.
### Sample Sketch
**Channel Profile Near Abutments**

**Table: Channel Profile Along Abutments (Feet)**

<table>
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<th>Loc.</th>
<th>READINGS:</th>
<th>ROD PENETRATION:</th>
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<td>2011</td>
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<tr>
<td></td>
<td>BEGIN ABUTMENT</td>
<td></td>
</tr>
<tr>
<td>A</td>
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</tr>
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</table>

**Diagram: Channel Profile Near Abutments**

**Notes:**
- No significant changes.
- Water level from top of stem = 5.2 ft
- Minor erosion at Begin Left Wing Wall
- Water level from top of stem = 5.2 ft
- Begin Left Wing Wall footing now exposed. Maximum vertical footing reveal is 3 inches.
- Water level from top of stem = 5.2 ft
4B.3 - SUBSTRUCTURE UNDERMINING AND EROSION

Purpose

The purpose of collecting this information is to document undermining and/or erosion at the substructure unit.

What to Document

In addition to the above Channel Profile Near Substructures documentation, document any substructure undermining observed during inspection. Erosion and undermining problems at bridges over features other than water should also be documented.

How to Document

Documentation consists of a sketch showing the problem location and all three dimensions of the limits of material loss. If undermining extends under a footing with piles, their condition should be noted. Note type of streambed material and its average size.

In addition to any applicable sketch requirements for channel profile near substructures, sketches for substructure undermining and erosion should also show:

- The horizontal and vertical limits of material loss under the substructure.
- In the presence of piles, the following should be provided:
  - Pile-layout with spacing
  - Condition of pile: for example, awl penetration(s) for each exposed timber pile
  - Section loss including method of measurement
  - Vertical exposed length of each pile
  - Pile-tip elevation and the embedment length. For unknown pile-tip elevation, documentation should state “pile-tip information unknown”.

See figures 4B.3.1 thru 4B.3.3 for sample sketches.
### CHANNEL PROFILE AND UNDERMINING READINGS ALONG PIER (FT)

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(-) Depth Change indicates scour. (+) Depth change indicates aggradation

### Notes

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<td>2011</td>
<td>New undermining at S.E. corner (values highlighted in table)</td>
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<tr>
<td>2013</td>
<td>Undermining has increased.</td>
</tr>
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<td></td>
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**SAMPLE SKETCH**

CHANNEL PROFILE WITH UNDERMINING NEAR PIER

Figure 4B.3.1
EROSION AND UNDERMINING OF END ABUTMENT

Figure 4B.3.2

SAMPLE SKETCH
EROSION AND UNDERMINING OF ABUTMENT
Figure 4B.3.2
SCOUR AND UNDERMINING OF END ABUTMENT

STREAM BED:
MIXED COARSE
GRAVEL AND SAND.

ELEVATION
END ABUTMENT

PLAN
END ABUTMENT

SAMPLE SKETCH
SCOUR AND UNDERMINING AT ABUTMENT
Figure 4B.3.3
4B.4 - STREAM ALIGNMENT SKETCH

Any deficiencies or alignment problems in the stream channel that cannot adequately be shown in photos should be sketched in a simple plan view.

A plan-view sketch should indicate:

- Deficiencies in the stream channel
- Locations of debris, siltation, scour pockets and loss of bank protection
- Stream flow direction and estimated angle of flow. Estimate the angle of flow relative to an axis perpendicular to the bridge fascia. For flow parallel to the substructure faces, the angle is zero.
- The general configuration of the bridge including dolphins and fender systems

When no stream alignment sketch is provided, indicate direction of flow on the Condition Photo Location Plan (see figure 2.5.4.1) or within the Stream Alignment comments (for example: “stream flow from left fascia to right fascia, 10 degrees toward end abutment”).

See figure 4B.4.1 for a sample sketch.
SAMPLE
STREAM ALIGNMENT SKETCH
Figure 4B.4.1
This page intentionally left blank.
Abutment - Definition

This is a substructure at the end of a single span or at the extreme end of a multi-span superstructure. An abutment provides support for the bridge and retains or supports the approach fill.

Typical Abutment Types

Abutments are classified according to their position and interaction with respect to the approach embankment. The most common types are shown in figures 4C.1.1 thru 4C.1.11. Some of the more common designs include:

- Cantilever abutment (Figure 4C.1.1), consisting of a vertical arm (stem or backwall) rigidly fixed to a horizontal base (footing). Lateral thrust of earth pressure is resisted by opposing cantilever action of the stem and footing. The stem transmits horizontal pressure to the footing, which in turn provides resistance from the dead weight of the abutment and the embankment material resting on the footing.

- Gravity abutment (Figure 4C.1.2), often unreinforced or minimally reinforced concrete. Both faces of the stem can be beveled, forming a wide bottom tapering to a narrower top. Horizontal earth pressures are resisted through its own dead weight.
Abutments and Wingwalls

- **Counterfort abutment** (Figure 4C.1.3), similar to the cantilever but with the addition of counterforts (triangular crosswalls) which connect the vertical walls to the base. The counterforts, spaced at regular intervals, provide resistance to bending moments in the stem.

- **Crib abutment**, consisting of individual structural units assembled to form an open cellular structure. The cells are filled with suitable material (gravel, concrete, etc.) that along with the units themselves, provide support for the structures.

- **Soldier Pile abutment** (Figure 4C.1.4), consisting of a series of soldier beams supporting horizontal lagging to retain the embankment. The soldier beam is a steel or timber pile driven into the earth with its projecting end used as a cantilever beam. Horizontal lagging usually consists of either timber planking or steel plates. Sheet piling abutments are constructed similarly.

- **Stub abutments** (Figure 4C.1.5) are set near the top of an embankment or slope, having a relatively short vertical height. They may be supported upon piles or founded on gravel fill, the embankment, or the natural ground. The pedestals are supported directly on the footing and there is no stem, therefore, rate the stem 8. The backwall retains the fill by spanning horizontally between pedestals.

- **Spill-through (or open) abutments** (Figure 4C.1.6), consist of vertical columns or buttresses supporting a capbeam. The approach embankment is only partially retained by the abutment. The embankment extends on its natural slope through the openings between the vertical supports.

- **Integral abutments** (Figure 4C.1.7) are cast monolithically with the bridge deck and superstructure. They encase the ends of the superstructure and are supported on a single row of piles. This type of abutment is designed to allow rotational and longitudinal bridge movement.

- **Semi-Integral abutments** (Figure 4C.1.8) combine a conventional stem (from a cantilever abutment) and a separate backwall cast monolithically with the deck and bridge superstructure. This type of abutment has normal bearings. The backwall, separate of the stem, allows rotational and/or longitudinal bridge movement.

- **Mechanically stabilized earth abutments**, particularly reinforced earth abutments (Figure 4C.1.9) are systems consisting of three principal components: a face (usually precast concrete panels), strips or grids (usually galvanized steel), and a granular backfill. Alternating layers of granular fill and reinforcing strips are placed in lifts and connected to the facing panels. The basic concept is that horizontal earth pressure normally on the vertical wall is transferred to the metal strips through friction developed between the strips and backfill.

- **Box Culvert and Frame Abutments** (Figures 4C.1.10 & 4C.1.11) incorporate a moment transfer connection between the stem and superstructure.
TYPICAL ABUTMENT TYPES

TYPICAL CANTILEVER ABUTMENT
Figure 4C.1.1

TYPICAL GRAVITY ABUTMENT
(Wingwalls not Shown)
Figure 4C.1.2
Abutments and Wingwalls

TYPICAL COUNTERFORT ABUTMENT
Figure 4C.1.3

TYPICAL SOLDIER PILE ABUTMENT
(STEEL SHEET PILE ABUTMENT is similar)
(Wingwalls not Shown)
Figure 4C.1.4
TYPICAL STUB ABUTMENT
(Wingwalls not Shown)
Figure 4C.1.5

TYPICAL SPILL THROUGH ABUTMENT
Figure 4C.1.6
Abutments and Wingwalls

TYPICAL INTEGRAL ABUTMENT
Figure 4C.1.7

TYPICAL SEMI-INTEGRAL ABUTMENT
Figure 4C.1.8
TYPICAL MECHANICALLY STABILIZED EARTH ABUTMENT
(Wingwalls not Shown)
Figure 4C.1.9

The following abutment elements are rated 8:
- Bearing, anchor bolts, pads
- Pedestals
- Backwall

TYPICAL CLOSED MULTI-CELL BOX CULVERT
Figure 4C.1.10
The following abutment elements are rated 8:

- Bearing, anchor bolts, pads
- Pedestals
- Backwall

**TYPICAL MULTI-SPAN CONCRETE FRAME**

Figure 4C.1.11

**Typical Materials**

See ‘General Bridge material Deficiencies’ under Chapter 3.6.
4C.2 – ABUTMENT JOINT WITH DECK

Deck joints are designed to accommodate various bridge-deck movements under live loading and/or during thermal expansion and contraction. Closed joints should prevent leakage to components below the deck and provide a smooth transition between the deck and approach roadway. Open joints are not designed to be watertight; water and debris are free to pass through the joint where they may be diverted from other bridge components by use of a trough or similar device.

What To Rate

Rate the condition of the transverse deck joint. In determining the rating, include the condition of the adjacent header concrete, armor angle (if present) and smoothness of the transition to the deck. Baffles, troughs, plumbing, and joint-support framing should also be included in rating this element. Figure 4C.2.1 shows a typical joint with deck. Figure 4C.2.2 shows a detail of a joint with deck above the backwall. Sometimes, a functioning deck joint may be located behind a backwall. This too, should be rated under "Joint with Deck." For ramp bridges with a transverse deck joint between the mainline and ramp bridges, rate the joint under the abutments section.

EXCEPTIONS: Some bridges with rigid-frames, integral abutments, semi-integral abutments, "jointless" abutments, filled-arches, pipes, and culvert details have no ratable deck joints. Construction details with no deck joint shall be rated 8.

Figure 4C.2.3 shows a construction joint detail that was not designed to function as a deck joint. This detail is typically used where deck slabs and approach slabs move in unison over the backwall. This joint is included in the rating for the approach pavement (see Chapter 5.5).
JOINT WITH DECK ABOVE BACKWALL
Figure 4C.2.2

NO JOINT WITH DECK - "JOINTLESS"
(Rate 8)
Figure 4C.2.3
Typical Joints

Typical open joints include:

- Finger-plate joints (or tooth-plate joints), consisting of two steel plates with interlocking fingers or teeth. They are normally used on longer-span bridges where greater expansion is required. Though not watertight, troughs may exist to channel water and debris away from structural elements below.

- Sliding-plate joints, consisting of horizontally positioned flat steel plates anchored into the bridge deck along one edge. They are allowed to slide across an angle anchored to the opposite face of the opening. Though not watertight, they generally resist passage of debris.

- Formed joints simply provide a gap between the bridge deck and abutment backwall. They are generally found on short-span bridges and provide for less movement than other joint types. The joints may have unprotected concrete edges or may be armored with steel angles. Though not watertight, troughs may exist to channel water and debris away from structural elements below.

Some typical closed joints include:

- Elastomeric joints, generally consisting of steel plates and angles reinforcing a neoprene cover. The steel provides for anchorage and load transfer. The neoprene covers and protects steel components, prevents passage of water and debris, and due to its elastomeric properties, allows movement of the bridge deck.

- Poured joint seals, consisting of two materials: a base composed of preformed expansion joint filler topped by a poured sealant. This type of joint can accommodate only minor movements and is generally used on short-span structures.

- Compression seals, consisting of rectangles of neoprene. Sealer shape and elasticity allow for full recovery after being distorted by deck expansion and contraction. To function properly, the seal must be maintained in a partially compressed state.

- Cellular seals, similar to compression seals, allow for expansion and contraction both perpendicular and parallel to the joint. This joint type is generally used on curved or skewed structures where parallel movement (racking) may occur.

- Modular joint systems, consisting of individual seals (usually compression seals) interconnected with steel and supported by their own stringer systems. They are normally used where large movements are anticipated.

What To Look For

Check that the size of opening is reasonable for the temperature conditions at the time of inspection and there are no vertical displacements of the joint or its elements. Check for debris in the joint or joint trough, and for deterioration of the joint materials. When under the deck, check for deterioration
of the joint supports, deterioration or displacement of troughs and baffles, and leakage of joints intended to seal out water.

Joints designed to seal out water, but leaking, should be rated 4 or lower for their failure to function as designed.

Similarly, downrate clogged joint troughs and/or plumbing systems at least one number, depending upon the effects of clogging. Rate all exposed parts of the joint plumbing system under the joint element.

**Rating Examples**

7 - New Condition

5 - Joint components may show some deterioration such as minor asphalt raveling next to armor angles or filler material deterioration, but the joint is still watertight (if applicable).

3 - The closed joint shows evidence of significant leakage. Cracked/spalled concrete header or clogged/broken trough allows significant leakage to superstructure elements. Joint components show significant deterioration.

1 - Parts of the joint are loose and protruding so that they could snag vehicular traffic or a joint seal has become totally nonfunctional. Concrete header is extremely deteriorated, possibly with exposed reinforcement.

![Figure 4C.2.4 – Rate 7](image)

*The joint shown is in new condition.*
The bridge deck joint is leaking significantly as evident by the wet abutment stem. If this were an isolated condition, then the joint may rate 4.

The modular joint sealant exhibits failure with debonding in several locations throughout the width of the bridge. This condition allows for leakage through the joint and onto the superstructure below.
Figure 4C.2.7 - Rate 3
The open joint trough is clogged with debris forcing drainage onto the superstructure.

Figure 4C.2.8 - Rate 1
Near the shoulder and extending into the roadway, the steel angle on the approach side has dropped. The top leg of the deck side angle is torn and missing creating a sharp tire hazard. The rubber seal has fallen in this area and the remainder of the seal is deteriorated, torn and leaking.
4C.3 - BEARINGS, ANCHOR BOLTS & PADS

Bearings are designed to transmit and distribute superstructure loads to the substructure, while allowing the superstructure to undergo necessary movements and rotations.

Bearings are subjected to various forces. Vertical forces are produced by dead and live loads. Longitudinal forces are caused by thermal expansion and contraction of the superstructure. Highly skewed or curved structures may induce both longitudinal and transverse forces at bearings. Transverse forces may also develop from wind, earthquake, or other horizontal forces. Uplift forces may develop on continuous beam with unbalanced span arrangements, cantilever anchor spans, curved structures or bridges with severe skews.

Bearings are also subjected to various superstructure movements. Longitudinal movements due to thermal expansion and contraction must be accommodated to prevent buildup of internal stresses. End rotation due to dead-load and live-load deflections also need to be allowed. Lateral movements and rotations on highly skewed, curved or very wide structures may be significant.

What To Rate

Rate the condition of bearings or bearing pads and anchor bolts. The rating should reflect the condition of the worst bearing at an abutment. Do not average conditions of all the bearings. For structures such as jack arches or prestressed concrete, where only parts of the bearing systems are visible, rate what can be seen. In deciding the rating, consider the bearing's ability to support the superstructure, and if required, allow superstructure translation and rotation.

EXCEPTIONS: This element is not applicable (Rating 8) to the following types of structures: concrete or masonry arches, integral abutments, rigid frames, slabs, box culverts, and pipes.

SPECIAL CASE: RAMP BRIDGES

Ramp bridges connected to mainline bridges are oriented such that the beginning of the ramp bridge is at the mainline bridge. If the beginning of the ramp bridge is supported by a pier that also supports a part of the mainline bridge, the bearings, pedestals and top of pier cap supporting the ramp structure should be rated as begin abutment bearings and bridge seat and pedestals for the ramp bridge even though there is no beginning abutment. When this is done, a remark needs to be provided. If mainline pier deficiencies adversely affect the ramp bridge, cross-referenced remarks on the mainline and ramp inspection reports are necessary.
Typical Bearings

Bridge bearings are either fixed or expansion. The principal difference between the two is that fixed bearings do not allow for translation of the superstructure. Generally, both bearing types are designed to allow rotational movement of the superstructure due to deflections. This rotational movement may be accommodated by rollers, pins, hinges, curved surfaces, or by deformation of elastic materials.

Both fixed and expansion bearings are designed in several configurations: steel, neoprene, PTFE (Teflon), bronze, or some combination of these materials. Basic components generally include:

- **Sole Plate** – a steel plate attached to the bottom flange of a girder or beam or to the bottom chord of a truss. Occasionally, no sole plate will exist and the lower flange or bottom of the section will rest directly on the bearing.

- **Bearing or Bearing Surface** – secured to the sole plate and masonry plate and permits rotation and/or translation, and transmits forces from the sole plate to the masonry plate.

- **Masonry Plate** – a steel plate attached to the supporting member or abutment. A masonry plate serves to distribute vertical forces from the bearing and superstructure above to the substructure below. Bearing pads, acting as vertical load-transmitting devices, may be placed between the masonry plate and substructure. Occasionally, no masonry plate will exist and the bearing will rest directly on the supporting member or substructure.

- **Anchor Bolts** – hold the bearing to a substructure unit. They may provide restraint against transverse movement and for fixed bearings provide restraint against longitudinal movement. Anchor bolts may also be designed to resist vertical (uplift) forces.

Not all bearings have these four distinct elements, but all do have a bearing or a bearing surface. Several types of expansion bearings have been designed to accommodate superstructure movement:

- **Steel Sliding-Plate Bearings** allow translational movement through action of one plate sliding on another. Because their use is generally restricted to shorter-span structures, allowance for rotational movement may not be required. Other materials, such as bronze, lead, asbestos, or PTFE (Teflon), may be incorporated to reduce friction. These bearings were widely used in NYS through the 1970s. Steel sliding bearings also require periodic maintenance to ensure their performance. This bearing type is no longer used on new bridges.

- **Roller Bearings** allow longitudinal movement through rolling action of a cylinder (roller) or group of cylinders (roller nest) between a sole plate and masonry plate. Rotational movement may be accommodated by rolling action of the roller(s) or by rotation about a bearing pin. They are usually made of structural steel.

- **Rocker Bearings** are generally used when either a large vertical load or a substantial amount of translation or a combination of both is anticipated. Pintles are used to maintain alignment and resist longitudinal and transverse forces. Longitudinal movement is accommodated by rocking action about the pintles.
Elastomeric Bearings allow rotation and horizontal movement by elastic deformation of the bearing itself. They are commonly used for prestressed concrete or steel bridges of short and moderate span lengths. These bearings are composed of natural rubber or neoprene pads and may be laminated by incorporating steel or fiberglass plates between the pads. To restrain horizontal movement of adjacent prestressed concrete beams, elastomeric bearings may use anchoring dowels passing through the bearing from the superstructure to the substructure.

Multi-Rotational Pot Bearings allow horizontal movement through use of sliding plates and multidimensional rotation through deformation of a sealed elastomer. They are normally used where a large vertical load, a substantial amount of translation in two directions, or a combination of both is anticipated. These bearings are constructed of a steel cylinder (pot) which contains a neoprene pad. A steel piston rests on the pad and brass rings confine the pad within the pot. Under high pressure, the pad acts in a manner resembling a hydraulic fluid and allows rotation of the piston. Translation is usually accommodated by PTFE (Teflon) sheets sliding on polished stainless steel.

Multi-Rotational Disk Bearings are similar in use and function to Multi-Rotational Pot Bearings with the distinct difference that an unconfined polyether urethane disk accommodates rotation and translation.

What To Look For

For all types of expansion bearings, look for signs of distress to other bridge components caused by frozen bearings, such as cracked or sheared pedestals.

Misalignment of bearing components should be measured and individually tracked as necessary to document rate of change. It is important to note the temperature and other weather conditions at the time the tracking readings are taken.

Steel Bearings: Assess the bearing for lateral or vertical displacement (uplift), sheared bolts, cracked welds, and presence of debris or heavy corrosion. If corrosion is present, assess the degree of deterioration and its effect on the ability of the bearing to transmit load and permit movements and rotation. Check for bearing misalignment (overextension toward the edge of or off the masonry plate, or tipping of the bearing beyond its proper position for the ambient temperature). Check for shoved or irregular alignment of deck joints as an indicator of potential problems at the bearings. Check for stress cracks that may develop if the bearings have frozen. If present, verify that masonry plates are anchored and not "walking." When inspecting pot bearings, also look for cracking or splitting of the piston or pot, leaking of the piston seal, ripped or torn Teflon surfaces, or non-uniform compression across bearing.

Elastomeric Bearings: Look for debris buildup, delamination, cracking deterioration, cuts, and bond failure between the bearing element and top or bottom load plates. Check for excessive distortion, such as shearing beyond anticipated longitudinal displacement, or non-uniform compression or twisting of the bearing beyond anticipated rotational displacement. Look for excessive bulging or cracking of the elastomer, which may result from excessive load or over rotation.
High Rocker Bearings: High rocker bearings are defined as an expansion bearing that uses a curved bearing surface (like a rocking chair) to allow expansion and contraction of a superstructure. A high rocker bearing is generally taller than it is wide and, for these requirements to apply, at least 8 inches high. “Abnormal behavior” of high rocker bearings refers to bearings that are in the contracted position in warm weather and bearings that are in the expanded position in cold weather.

Action to be taken

During any inspection of high rocker bearings, inspectors should consider what the normal behavior is for this type of bearing. In New York State, bearings are generally designed to be set at their neutral (vertical) position at 68° F. The design temperature range for bearings with steel superstructures in Regions 1 thru 9 is -30° to 120° F, and in Regions 10 and 11 the range is 0° to 120° F. Generally, this means rocker bearings should be nearly vertical (no tilt) at 68°. Normal behavior for this type of bearing is to tilt away from the center of the span when the temperature rises and the superstructure expands. The bearings should tilt back toward the center of the span as the temperature falls and the superstructure contracts. Note that when a bridge has two lines of expansion rocker bearings on a pier and a joint in the deck over the pier, the bearings should tilt toward each other when the temperature is high and tilt away from each other when the ambient temperature is colder than the midrange temperature. Abnormal movement of the bearings may indicate movement of the substructure on which the rocker bearing is founded or movement of the substructure with the fixed bearings. An effort should be made to determine if either of these cases caused the problem.

Documentation of condition of high rocker bearings

The following documentation is required for each location where high rocker bearings rated 4 or lower due to excessive tilt or abnormal behavior are found on a bridge. This information shall, at a minimum, be collected from the most distressed bearing from each line of bearings and be documented using the guidelines below at each inspection. In the case of a single pier with two lines of expansion (rocker type) bearings for two different spans, two bearings will be recorded. For example, the “worst of” bearing on one span (e.g. span 1) may be rated “3”, while the “worst of” bearing on the other span (e.g. span 2) could be rated “4”. The Inspector shall document both of these bearings in the table to represent the “worst of” bearings in each line of bearings. The rating reported in the Inspection Report for the bearing element will remain the “worst of” all of the bearings on the pier. The inspection report shall include all the following that apply:

A. Bearing notes shall include (as necessary) statements describing:

1. Ambient temperature during inspection.
2. Documentation of extension or contraction (tilt). The angle of rotation, θ, should be measured with a tilt meter or calculated from the measurements taken during the inspection. See the sketch below for the minimum measurements needed.
3. Documentation of behavior/movement. Record observations regarding direction of movement of the bearing if the bearing shows signs of movement (for example, cracks in the paint or lighter color rust stains) and if the bearing has sufficient capacity to move further in the direction of travel under temperature extremes.
4. Presence of corrosion (including pack rust) or any debris that could inhibit proper function and documentation of section loss to any portion of the bearing assembly including anchor bolts.
5. Any sheared off or bent anchor bolts and location of such bolts.
6. While the rating of the inspection element “Bearings” is a “worst of” type rating, documentation of the condition of other bearings is required. For example, the bearing for girder G1 rates a “3” due to... (give explanation), the rest of the bearings would rate “5”.

B. Rocker Bearing Field Documentation Summary

The Rocker Bearing Field Documentation Summary shall be included in the Inspection Report. The summary shall include sketches and a table with the following data, at a minimum, for the “worst of” bearing in each line of rocker bearings on a pier (including piers with two sets of expansion bearings as described above) or on an abutment:

Ambient temperature, angle of rotation (with an indication if this angle is calculated or measured), dimensions A, B, C, D, E and X as shown in the documentation sketch shown on the following table.

Rocker Bearing Field Documentation Summary

1. Reference Sketch:
   A = Height of rocker
   B = High corner of rocker plate
   C = Low corner of rocker plate
   D = Width of rocker plate
   θ = Angle of rotation (tilt)
   E = Eccentricity (translation)
   X = Minimum clear distance between girders or from girder to abutment

2. Bearing Data Table:

<table>
<thead>
<tr>
<th>Date</th>
<th>Bearing Location</th>
<th>Ambient Temp</th>
<th>Dim &quot;A&quot;</th>
<th>Dim &quot;B&quot;</th>
<th>Dim &quot;C&quot;</th>
<th>Dim &quot;D&quot;</th>
<th>Dim &quot;X&quot;</th>
<th>Angle &quot;θ&quot;</th>
<th>Dim &quot;E&quot;</th>
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In extreme situations a special inspection should be scheduled to check the bearings at a higher ambient temperature, if the bearings are over extended or at a lower temperature if the bearings are over contracted.
The amount of allowable tilt varies with each type and configuration of rocker bearing. To compare the actual tilt to the allowable tilt the inspector should determine the allowable tilt from the record plans. If no plans of the bearings are available, the inspector should determine an acceptable tilt from the actual measurements assuming that the rocker should not bear on the outer quarter of the “D” dimension of the rocker as shown in the Section view above.

The QC engineer should check the calculations and the measurements that determined the allowable tilt. Note that the tangent or bearing point between the rocker and masonry plate should always be located in the middle half of “D”. Due to the wide variety of rocker bearings, engineering judgment is required when comparing the allowable tilt to the actual tilt and if a flag is required.

**Anchor Bolts:** Missing or bent bolts. Each anchor bolt should be tapped with a heavy hammer to determine if it is still firmly connected to the substructure. Loose or missing anchor bolt nuts on elastomeric bearings are generally not a reason to downgrade the rating of the bearing unless the bearing is subject to uplift forces. The inspector should note the missing nuts in the report.

**Rating Examples**

When rating the condition of the bearing system (bearings or pads and anchor bolts) consider the bearing’s function as well as the condition. To function properly, a bearing system must support (or anchor) the superstructure and provide for end-of-span movement. If not functioning as designed, excessive stresses may be induced in the superstructure or substructure that could shorten the usable life. Improper positioning may lead to serious consequences. Additional superstructure movement may cause damage to other elements, such as backwalls, or may cause extension of the bearing beyond safe limits.

7 - Bearings are in new or like-new condition, in proper position for the ambient temperature.

5 - Minor deterioration, but still allow movement, if required. Bearings should be reasonably close to proper position for the ambient temperature.

3 - Serious deterioration or deformation of the bearings, improper positioning of the bearings, and/or frozen bearings. Secondary effects of frozen bearings, such as sheared anchor bolts and/or cracked pedestals may be evident.

1 - Bearing is completely inoperative or has failed, or is extended in a position no longer providing support.
Figure 4C.3.1 – Rate 7
The pot bearing is in new condition and in the proper position for the ambient temperature. All bearings at the abutment are in this condition.

Figure 4C.3.2 – Rate 4
The elastomeric expansion bearing was photographed when the ambient air temperature was 28°F. The bearing should be in a slightly contracted position, not overextended. Though materially the bearing would rate 7, the overextension rates 4.
Figure 4C.3.3 – Rate 3
Expansion Rocker Bearings are improperly rotated for the ambient temperature. The degree of rotation has not changed as expected over a wide temperature range as indicated through the Rocker Bearings monitoring documentation. Paint buildup and pack rust are present under the rockers hindering rotation and expansion. Do not consider the temporary support when rating the bearing.

Figure 4C.3.4 – Rate 2
Shown is an elastomeric bearing with a sole plate, but no masonry plate. The neoprene pad is deformed with bulging, cracking and tearing.
The expansion sliding plate bearing is severely out of alignment and in a contracted position at an ambient air temperature of 80°F (27°C). The bearing should be in an expanded position. Winter temperatures will probably cause the bearing to contract further, possibly sliding off the masonry plate.

This expansion bearing is heavily corroded, causing extensive deterioration to the keeper plates, rollers, and bearing component. Debris has infiltrated between the rollers, hindering expansion, which may be inducing excessive stresses in the superstructure or substructure.
The original bearing is currently removed and a temporary jacking operation provides support. Rate the missing bearing and do not rate the temporary support.

The multi-rotational expansion bearing is floating with the elastomeric disc lifted 1/8" above the pot. The girder vibrates slightly when traffic passes, but the bearing was not observed to come into contact under load. Otherwise, the bearing appears to be in good material condition with intact sliding surfaces and paint.
4C.4 - BRIDGE SEAT AND PEDESTALS

Most commonly, the bridge seat is the top surface of an abutment stem on which the superstructure may be placed and supported and from which pedestals or a backwall may rise. The bridge seat may be flat or stepped in height to provide a specific bearing-seat elevation. Pedestals on the seat support the bearings, transfer loads to the substructure and make up any difference in elevation between the seat top and the bottom of bearing.

What To Rate

For raised pedestals, rate the entire pedestal, including the sides. For abutments without raised pedestals, rate the condition of the area under the bearings or superstructure elements (i.e., beams or girders) including the horizontal and the vertical surfaces immediately next to the bearing which represents the point of load transfer between the bearing (or superstructure) and stem.

For bridge seats, rate the condition of the top of the abutment stem between pedestals.

For rigid frames and concrete box-culverts with a construction joint between the leg of the abutment (stem) and the primary member, rate this bearing surface as a bridge seat.

Rate the condition of the abutment bridge seat and pedestals. The rating should reflect the condition of the worst pedestal at an abutment or condition of the bridge seat, whichever results in the lower rating.

EXCEPTIONS: Metal or concrete pipes and concrete or masonry arches do not have bridge seats or pedestals. Other bridge types that do not have bridge seats or pedestals include bridges with integral abutments, rigid concrete frames (without a construction joint), and precast box culverts (without a construction joint). Where bridge seats and pedestals do not exist, use the rating of 8.

SPECIAL CASE: RAMP BRIDGES

Ramp bridges connected to mainline bridges are oriented such that the beginning of the ramp bridge is at the mainline bridge. If the beginning of the ramp bridge is supported by a pier that also supports a part of the mainline bridge, the bearings, pedestals and top of pier cap supporting the ramp structure should be rated as begin abutment bearings and bridge seat and pedestals for the ramp bridge, even though there is no beginning abutment. When this is done, a remark needs to be provided. If mainline pier deficiencies adversely affect the ramp bridge, cross-referenced remarks on the mainline and ramp inspection reports are necessary.

Typical Types

Bridge seats and pedestals are usually made of concrete, although masonry, timber, or steel may be found. Concrete may be unreinforced or reinforced with steel rebar.
What To Look For

If bridge seats and/or pedestals are concrete, look for such signs of deterioration as cracking, scaling, spalling, delamination, or leaching. Strike with a hammer to determine concrete soundness. For masonry, look for cracks and deterioration of mortar joints or stones and bricks and loss of masonry. For steel, look for loss of section, bowing, or buckling. For timber, check for rotting by using a hammer, awl, or knife and visually inspect for insect attack. Look for debris buildup (soil, leaves, bird droppings, etc.) on top of the bridge seat or pedestals that can trap moisture and cause deterioration.

Rating Examples

7 - New or like-new condition.

5 - The bridge seat or pedestal may have minor deterioration, such as minor mapcracking without delamination, possible hairline shrinkage or temperature cracks (not stress cracks), and/or minor spalling or scaling that does not involve the area under the masonry plate of the bearing.

3 - There may be heavy map cracking and efflorescence with indications of hollowness or heavy scaling that involves most or all of the bridge seat or pedestal. The bridge seats or pedestals have significant debris buildup. Spalling exists that results in the loss of bearing area. Working stress cracks caused by compressive overstress (splitting) or induced by frozen bearings that have not yet progressed to a critical state would also warrant a 3 rating.

1 - This represents deterioration or a stress crack so severe that failure of a bridge seat or pedestal has occurred or is imminent.

Figure 4C.4.1 – Rate 4
Arrows indicate the location of the cast-in-place, box culvert bridge seat. Minor cracking and localized spalling are present. Damp concrete along the seat indicates leakage. Tapping with a hammer reveals delaminations in the concrete.
The pedestal has hollow concrete areas at all sides. A 5 inch high by 3 inch deep, concrete area has spalled and the reinforcement is exposed, undermining the bearing less than 5%.

Pigeon droppings have accumulated up to 12 inches thick on the bridge seat in all bays.
Severe spalling and scaling of the pedestal has significantly undermined the fixed bearing masonry plate and exposed all four anchor bolts.

The bearing support area is undermined 100%. The front of the bearing plates have deflected downward and the bearing plates move when hit with a hammer.
4C.5 – BACKWALLS

These are designed primarily as retaining walls, but may also support the end of the bridge deck or the approach slab.

What To Rate

Rate the backwall, but do not include the backwall header if there is one. Backwall headers are rated under Joint With Deck. For jack-arch bridges that do not have recessed backwalls, rate the abutment sections between the stringers as backwalls.

EXCEPTIONS: This element is not applicable (Rating 8) to the following structure types: box culverts, pipe culverts, integral abutments, rigid frames, slabs, filled arches, and some spill-through abutments.

The condition of protective coatings on the concrete is not included in the backwall rating. The condition of purely aesthetic curtain walls should not affect the backwall rating.

Typical Types

They are usually concrete, but masonry, timber, and steel can be used.

What To Look For

Signs of deterioration, such as cracking, leaching, and delamination of the concrete. Sound the backwall for delamination by tapping with a hammer. For steel, look for loss of section or bulging. For timber, look for insect damage and rot. Whatever type, check for and document signs of tipping or other movement. A common problem is pavement shove damage, usually showing as large cracks in concrete backwalls or bowing of steel or wooden backwalls.

Rating Examples

7 - New or like-new condition.

5 - There may be moderate scaling or minor spalling of concrete, minor rust of steel, or dampening of wood. Concrete backwalls would show no signs of hollowness or delamination when struck with a hammer.

3 - Serious deterioration or distress (signs of movement or large cracks, section loss of steel, or timber rot). Some minor amounts of embankment material may be spilling through backwall cracks.

1 - The backwall is either deteriorated so badly or cracked or moved so that it cannot retain backfill material or support the approach slab.
Figure 4C.5.1 – Rate 5
The concrete backwall has fine cracks with light efflorescence and minor random scaling. Testing with a hammer produced solid soundings.

Figure 4C.5.2 – Rate 4
The backwall between girders of a jack-arch bridge exhibits a spall 1.5 inch deep over a 1 ft x 1 ft area. Hammer testing reveals hollow sounding in immediately adjacent areas while other bays generally produced solid soundings with some random hollow sounding areas.
Figure 4C.5.3 – Rate 3
The backwall is heavily and deeply spalled. Near the bottom left of the bay (below hammer) a full depth hole has developed allowing minor amounts of embankment to spill through.

Figure 4C.5.4 – Rate 3
The backwall is seriously deteriorated. No signs of distress or movement have been detected, but concrete condition is poor, extensively spalled and crumbly with exposed reinforcement.
4C.6 - ABUTMENT STEM

This provides end support for the bridge and retains the approach embankment.

What To Rate

- The stem of a solid abutment (Figures 4C.1.1 and 4C.1.2).
- Counterfort abutment (Figure 4C.1.3).
- Piles and lagging of a soldier pile abutment (Figure 4C.1.4) or driven sheeting.
- Columns and cap of a spill-through abutment (Figure 4C.1.6).
- Pile-cap of an integral abutment (Figure 4C.1.7).
- The stem of a semi-integral abutment (Figure 4C.1.8).
- Mechanically stabilized earth system (MSES) when critical for abutment stability (Figure 4C.1.9).
- Legs of concrete rigid frames (Figure 7.2.1).
- Vertical supports (if any) for metal, concrete or masonry arches and end walls of concrete culverts (Figure 7.2.1)

EXCEPTIONS: Round and elliptical-pipe structures and stub abutments (Figure 4C.1.5) do not have stems and this element thus should be rated 8. Arches framing directly into footings or rock also do not have stems. A special case is made for stems (and wingwalls) which have non-structural stone or brick facing. When rating such elements, facing material should be considered only to the extent that its condition indicates the condition of what it is covering. Problems such as loose facings should be explained in the remarks.

Typical Stems

Reinforced and plain concrete are the materials most commonly encountered, but stone, masonry, wood lagging in soldier beams, steel or timber sheeting, and mechanically stabilized earth system abutments have also been used. In older (particularly smaller) bridges, it is common to find masonry stems with a poured or shot concrete structural or non-structural facing.

What To Look For

Deterioration of the stem is probably the most common problem. For concrete, check for cracking, leaching, spalling, and hollowness. Observation and use of an inspector's hammer are the methods most commonly used to detect material soundness. For masonry, check stones and joints for deterioration and note any missing stones. For steel, check for cracking, tearing, and if significant section loss has occurred, determine steel thickness. When timber stems are encountered, check for rotting with an inspector’s hammer, awl, or knife, and thoroughly observe the stem for evidence of insect attack. Check all stems for evidence of vertical and horizontal movement. The joint or separation generally existing between stem and wingwalls is a good location to observe differential movement. A hand level or plumbline can be used to check for tilting, through comparison with the batter shown in the plans. Once any signs of movement are observed, they should be recorded in the inspection report so that monitoring can easily continue during subsequent inspections. More
information on this topic can be found under "Footings and Piles."

Inspection should also include checking for lateral movement occurring when lateral forces acting on the wall exceed forces holding the structure in place.

The most common causes of lateral movement are foundation soil failure, seepage, changes in soil characteristics (e.g., frost action and ice), and long-term consolidation of the original soil. Inspection for lateral movement should include general overview of the structure for obvious movement, such as stem faces and wingwalls being displaced, displacement of curb faces, or bending of rail at abutment joints or piers. Check joints for a non-uniform dimension between the deck and approach slab. Check bearings for evidence of movement. Stem movement is often a result of scour under the footing. A detailed description of this condition can be found under "Erosion or Scour" later in this chapter.

Look for signs of movement, loss of embankment, and broken or cracked panels when inspecting mechanically stabilized earth abutments.

Evidence of foundation movement should result in downrating the stem because of its inability to adequately support the superstructure. Such movement also suggests an inability of the footing and pile systems to transmit substructure load to the foundation material, so they should also be downrated.

Soldier pile & lagging stems and sheet pile stems should be checked for any increase of reveal height, greater than as-designed, which may reduce system capacity.

**Rating Examples**

7 - Use for a stem in a new or like-new condition.

5 - Indicates minor deterioration, such as map cracking with efflorescence covering up to about 25% of the stem surface, but hammer-sounding would reveal little or no hollowness. Some spalling may be occurring, but would not cover more than about 10% of the stem nor would it encroach on the bridge seats or pedestals.

3 - Deterioration would be extensive and characterized by widespread map cracking, efflorescence, spalling and/or scaling. There may be structural cracks that are active. If there is evidence of significant movement whether or not the stem is deteriorated, a 3 rating would be used to reflect the stem's reduced ability to properly support the superstructure.

1 - Deterioration or movement is so severe that failure has occurred or is imminent.
Rated as a stem, the vertical portion of the precast concrete arch is in excellent condition.

The stem shown has one vertical crack. There are a few other minor cracks and some minor efflorescence, but the stem is solid.
Abutments and Wingwalls

Figure 4C.6.2 – Rate 4
The stem is half stone and half reinforced concrete. The stone portion of the wall is partially missing joint mortar resulting in slightly displaced masonry stones and backfill material spilling through gaps with evidence of vegetation growth. The concrete portion of the stem is in better condition with minor mapcracking.

Figure 4C.6.3 – Rate 3
The stem deterioration is significant. There are large areas of hollow sounding delaminations, heavy efflorescence and mapcracking. Reinforcement is exposed and deteriorating within the area of spalled concrete.
Figure 4C.6.4 – Rate 2
The repurposed stem (which rates 2) exhibits severe deterioration with spalling, efflorescence, large horizontal and vertical cracks, and horizontal displacement. Its failure could undermine the new spread footing abutment (which rates 6). Comment on both and rate stem 2.

Figure 4C.6.5 – Rate 1
The stem face is disconnected and rotating away from the soft and hollowed, core concrete. Reinforcement is disconnected and hanging. Further deterioration of the stem threatens settlement or possible collapse of the pedestals and superstructure.
4C.7 - WINGWALL INTRODUCTION

Wingwalls - Definition

These are retaining walls adjacent or attached to an abutment. They are intended to retain side slope material of an approach roadway embankment. Wingwalls do not support any portion of the superstructure.

Typical Wingwalls

They may have several geometric configurations, depending on design requirements.

- straight: extensions of the abutment wall
- splayed (flared): forming an acute angle with the bridge roadway
- U-Wings: parallel to the bridge roadway

They may be cast monolithically with the abutment or separately from the abutment.

For very long wingwalls, consider the length of the retaining wall that can be associated with the bridge. Lacking any other logical criterion, such as a vertical construction joint, use twice the height of the abutment as the length of wall to inspect. If a problem is evident beyond this limit, do not include it in the wingwall rating, but bring the problem to the Regional Structures Management Engineer's or the bridge owner's attention.

Wingwall Rating Elements

The following elements, if applicable, are to be rated as parts of the wingwall:

<table>
<thead>
<tr>
<th>WALLS</th>
<th>EROSION OR SCOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOTINGS</td>
<td>PILES</td>
</tr>
</tbody>
</table>

Each of these elements is described later in this chapter.
These are retaining walls adjacent or attached to an abutment that retains the approach roadway embankment.

**What To Rate**

Rate the condition of the wall and its ability to function properly. The rating for each end of the structure should not be an average of the two wingwalls at each abutment, but should represent the worst wingwall at each abutment.

**EXCEPTIONS:**

A special case is made for walls having non-structural stone or brick facings. When rating such walls, facing material should be considered only to the extent that its condition may indicate condition of what it is covering. Problems with facing materials (such as loose brick) should be explained in the written description.

**Typical Walls**

Reinforced and plain concrete are the materials most commonly encountered, but stone, masonry, timber lagging in soldier beams, cribbing, steel and timber sheeting are also used.

**What To Look For**

For concrete, check for cracking, leaching, spalling, scaling, and delamination. Observation and use of an inspector's hammer are the most common methods to determine material soundness. For masonry, check stones and joints for deterioration and note any missing stones. For steel, check for cracking/tearing, and if significant loss of section has occurred, determine steel thickness. When timber walls are encountered, check for rotting by using an inspector's hammer, awl, or knife, and thoroughly observe the wall for evidence of insect attack. When inspecting mechanically stabilized earth system walls, look for signs of movement, loss of embankment, and broken or cracked panels. Inspection should also include checking for lateral movement occurring when lateral forces acting on the wall exceed forces holding the structure in place.

The most common causes of lateral movement are foundation soil failure, seepage, changes in soil characteristics (e.g., frost action and ice), and long-term consolidation of the original soil. Inspection for lateral movement should include general overview of the structure for obvious movement, such as stem faces and wingwalls being displaced, displacement of curb faces, or bending of rail at abutment joints or piers. Check joints for a non-uniform dimension between the stem and wingwall. Wall movement is often a result of scour under the footing. A detailed description of this condition can be found under "Erosion or Scour" later in this chapter.

Evidence of foundation movement generally should result in a downrating of the wall because of its inability to adequately retain the approach embankment. Such movement also suggests an inability of the footing and pile system to transmit the substructure load to the foundation material so they should also be downrated.
Rating Examples

7 - New or like-new condition.

5 - Indicates minor deterioration, such as map cracking with efflorescence covering up to about 25% of the wall surface, but hammer-sounding would reveal little or no hollowness. Some spalling may be occurring, but would not cover more than about 10% of the wall.

3 - Deterioration would be extensive and characterized by widespread map cracking, efflorescence, spalling and/or scaling. There may be structural cracks that are active. If there is evidence of significant movement, whether or not the wall is deteriorated, a 3 rating would be used to reflect the wall's reduced ability to properly retain the approach embankment. If the condition appears to be stable, it may be appropriate to upgrade the rating to 4.

1 - Deterioration or movement is so severe that failure has occurred or is imminent.

Figure 4C.8.1 – Rate 6
The wingwall has one leaking, diagonal crack near the top. This wingwall is still solid.
Figure 4C.8.2 – Rate 4
The wingwall is map cracked over its entire surface and has efflorescence, but is still generally solid.

Figure 4C.8.3 – Rate 3
The gravity wingwall is heavily scaled and spalled over much of its face. The remainder is map cracked and hollow sounding. Although this wall is still functioning as designed, the extent of deterioration is serious.
This wingwall has several missing and displaced stones. The wingwall is still retaining the embankment, but is very seriously deteriorated. The wall appears unstable.

The top portion of the wingwall collapsed into the channel and the fill behind it has sloughed down the slope. The remaining concrete is heavily spalled and sounds hollow.
4C.9 - EROSION OR SCOUR
(Aboutments and Wingwalls)

What To Rate

Two separate conditions are examined, depending on whether the substructure is located in water. For those remote from bodies of water (and, thus not exposed to stream scour), this element is used to evaluate the erosion of the embankment material (and covering) in front of or under the substructure footing. Erosion is the wearing away of soil by flowing water. As used here, ‘soil’ includes embankment covering as well as the embankment material itself. ‘Flowing water’ refers to runoff from the bridge superstructure or approach roadway.

For substructures at the water's edge or founded in water (vulnerable to scour), this element is used to evaluate the extent of scour of the foundation material next to and under the footings. Scour is erosion of a riverbed area caused by stream flow. Scour must be documented in accord with Chapter 4, Section B. See also the description of underwater inspection in Appendix C.

For more information regarding scour caused by streams, see the introduction to Chapter 4, Section A.

What To Look For

Erosion: Disturbance or loss of embankment covering material and the embankment material above, in front of, and below the footing. An uneven surface on block paving may indicate loss of embankment material below. Other signs include soil marks at the face of abutments or wingwalls or other irregularities in the embankment surface. Comparison of existing conditions against earlier photographs often quickly indicates material loss or movement.

Scour: Loss of material from a streambed near a substructure resulting from stream flow. Included in the rating for this element is the loss of material above, around, and under the footing. The three types of scour that affect bridge substructures are general scour, contraction scour, and local scour. All three types of scour can seriously affect the performance of substructures. For additional information, refer to the introduction to Stream Channel, Chapter 4, Section A.

Careful comparison of information obtained over the course of several bridge inspections at the substructures is one of the best ways to detect how much scour has occurred. Finding the maximum extent of scour is difficult because it occurs during a flood and its true extent may be masked by sediment that refills the hole when flood waters recede. The inspector should use a rod where possible to probe loose sediments deposited along the bridge substructures. If the sediment is finer than the typical bed material, or if it is easily penetrated by the rod, this means that the present sediment has accumulated in the scour hole, and local scour is more severe than indicated by channel profile readings along the substructures. Details of required scour documentation are given in Chapter 4, Section B.
Rating Examples

7 - No evidence of scour, or for substructures remote from water, the embankment and its coverings are in "like-new" condition.

5 - Minor erosion or scour has occurred, such as displacement or loss of much of the block paving, or loss of embankment or streambed material where the top of the footing is partly exposed.

3 - Serious erosion or scour has occurred. This would include loss of embankment material including covering such as block paving or streambed material, to the extent that a substantial length of footing is undermined, but piles are present.

1 - Erosion or scour has progressed to the point where substructure failure has occurred or is imminent. This may include extensive undermining of a footing without piles, where the presence of piles is unknown, or with piles of questionable condition, even if the substructure has not yet failed.

**Note:** The presence and expected condition of piles is an important factor to consider in rating erosion and scour. Particularly for older bridges, the indication of piles on "as built" plans should be the only acceptable evidence, other than direct observation, that piles exist.

*Figure 4C.9.1 - Rate 7*

The abutment and wingwalls are well protected by the remnants of the previous substructure and the new stone bank protection. No evidence of erosion or scour exists.
The erosion shown has displaced most of the block paving in front of the abutment due to undermining of the embankment material. The footing is exposed but not undermined.

The abutment spread footing is fully exposed with undermining extending no more than several inches behind the toe for its entire length.
Figure 4C.9.4 – Rate 2
A large amount of the slope protection and embankment has washed/sloughed away. The exposed spill-thru abutment on piles is stable but further erosion could undermine the approach roadway.

Figure 4C.9.5 – Rate 1
The shale steam bed has eroded and severely undermined the substructure. The undermining extends the full length and nearly the entire width of the footing resulting in the potential for abutment and wingwall failure.
4C.10 - FOOTINGS  
(Abutments and Wingwalls)

These are designed to transmit substructure loads to the subgrade material or piles and to maintain the substructure at a particular alignment and grade.

What To Rate

Rate condition of the substructure footing and its ability to function properly. Also include any foundation material deficiencies that may be causing distress to the substructure or superstructure.

Typical Types

Footings are almost always concrete. They may be spread footings which transmit load directly to the subgrade or footings supported on piles. Spread footings may be constructed of hand-laid rock. When included in "abutmentless" bridges, the footing may be a metal pipe filled with concrete and placed on crushed stone. When abutments or wingwalls are constructed without a distinct footing, the area where the stem/wall meets the subgrade is rated as a footing.

What To Look For

Footings are usually visible only after erosion or scour has removed significant embankment material. When exposed, check for such signs of deterioration as cracking, leaching, spalling, and hollow-sounding concrete. Also check for signs of distress in the form of large cracks or splits, and document them for future reference. At locations where the footing is not visible, check for evidence of settlement or other movement; for example, if areas over footings are paved, these should be inspected for cracks following the periphery of the footing. Presence of such cracks may suggest that the spread footing had settled or rotated. For unpaved areas, lines in the soil could suggest the same. Check walls for full height vertical cracks and/or misalignment of wall faces at construction joints.

Vertical movement can occur in the form of uniform or differential settlement. Uniform settlement of all bridge substructure units has little effect on the structure. Differential settlement, however, is the more common form, and may produce serious distress. The most common causes of vertical movement are soil bearing failure, soil consolidation, scour, or deterioration of footing material. A hand level or plumbline can be used to check for differential settlement.

If aggradation or repair of subgrade prevents observation of previously noted conditions, the conditions and rating previously provided should be carried forward. In such cases, document why the information is being carried forward and the original observation date.

Exceptions

Rate ‘8’ for integral abutment stems and walls poured directly on piles. M.S.E.S. leveling pads are not designed to transfer loads to the subgrade and are therefore not rated as footings (Rate ‘8’).
Rating Examples

9 - This is the most frequently used rating. This code ("Unknown") is used when the footing is covered, with no signs of movement or settlement.

7 - Use when the footing is visible, functioning properly, and in a like-new condition.

5 - Indicates minor deterioration, such as minor cracking or spalling.

3 - Indicates significant movement of a substructure. Undermining of spread footing is causing distress to the substructure or superstructure. A footing significantly deteriorated by cracking or heavy spalling is also rated 3.

1 - Indicates a failed substructure or a footing that is undermined, cracked or spalled to such an extent that it can no longer transfer load from substructure to subgrade material or piles.

Figure 4C.10.1 – Rate 6
Shown is a footing on rock with only very minor surface scaling.
Severe scaling of the footing is occurring. The footing is still generally solid and functioning as designed.

A full height wingwall crack exists with up to 2 inches of horizontal displacement and forward rotation. The footing is not visible, however, the wall displacement and rotation indicates the footing has uneven settlement and its capacity is compromised.
The abutment and wingwall footings are heavily spalled.

The abutment was poured directly on subgrade. The interface between the entire length of the stem and the subgrade has deteriorated resulting in a significant loss of bearing area with differential settlement of the substructure.
4C.11 - PILES
(Abutments and Wingwalls)

Piles are generally used to transfer loads from the bridge substructure and footing to the underlying soil or rock. For bridges with integral abutments, piles transfer loads from the superstructure or abutment stem directly to soil or rock.

What To Rate

Footings, stems and walls on piles: Rate pile condition and ability to function properly.

Soldier piles or steel sheet piles (Figure 4C.1.4): Rate piles based on observed condition at existing ground or mudline if a deficiency is observed or when exposed due to scour or erosion. Otherwise, rate 9 – Unknown.

What To Look For

Piles are generally not visible, but if they can be seen, this may indicate a serious structural defect that must be investigated. For deterioration related only to the piles, look for the following:

**Steel:** Look for loss of section due to corrosion, buckling, web crippling, and for improper placement and/or alignment.

**Concrete:** Look for concrete deterioration, such as cracking, splitting, spalling, or efflorescence.

**Wood:** Wood piles, like the other types, are generally not visible, but if exposed (particularly above water) are highly susceptible to rot and insect attack. Use a hammer, awl, or knife to check for rot. Look for decay (fungal, bacterial), marine borers (limnoria, teredo, etc.), splitting, impact damage, fastener condition.

If the piles are not visible, the inspector can stand on the ground above a pile-supported footing and if strong vibrations occur when traffic passes above, this suggests that soil around the piles' upper portion had lost some fines and the piles now act as columns instead of piles.

For soldier pile and lagging walls, compare the observed height to the record plans and/or previous inspections. An increase in height may indicate the pile portion of the design is now exposed. This should be considered in both the pile and stem rating.

If aggradation or repair of subgrade prevents observation of previously noted conditions, the conditions and rating previously provided should be carried forward. In such cases, document why the information is being carried forward and the original observation date.
Rating Examples

9 - Unknown. This is a frequently used rating. Use if the inspector knows that piles exist, but are not visible, or if the inspector is not sure if piles exist.

8 - Not Applicable. Use this rating when the inspector is certain that piles do not exist.

7 - Use when piles are visible and are in like-new condition.

5 - Minor deterioration, but piles are functioning as designed. Use for steel piles with heavy rust but little section loss, or for concrete piles with minor spalling or cracking but basically solid.

3 - Serious deterioration; may involve significant loss of section in a steel pile, splitting or spalling in a concrete pile, or rotting of a timber pile.

1 - Extreme condition; one or more piles either critically deteriorated or completely failed.

Figure 4C.11.1 – Rate 6
Erosion at the stem face is evident by the dissimilar weathering of the sheet piling. Erosion has exposed a portion of the pile, minimally reducing its design length embedment. The exposed portion is in good condition and rated as piles.
The abutment and wingwall footings are undermined. Timber piles are now visible. Both the abutment and wingwall each have one split pile while the others are in good condition.

Several piles are now exposed due to tidal action. Their sacrificial, driven steel casings are corroded with localized areas of 100% section loss. The concrete is in good condition.
4C.12 - ABUTMENT RECOMMENDATION

What To Rate

This is a one number rating used to describe the abutment's overall condition and functional capability. This recommendation will normally reflect the scoring of the individual elements but it does not necessarily have to be the lowest of these ratings.

Rating

The inspector provides an overall evaluation of the abutment by using one of the rating numbers below:

8 - NOT APPLICABLE

7 - NEW CONDITION

6 - Used to shade between 5 and 7

5 - MINOR DETERIORATION BUT FUNCTIONING AS ORIGINALLY DESIGNED

4 - Used to shade between 3 and 5

3 - SERIOUS DETERIORATION OR NOT FUNCTIONING AS ORIGINALLY DESIGNED

2 - Used to shade between 1 and 3.

1 - TOTALLY DETERIORATED OR IN FAILED CONDITION
4C.13 - SUBSTRUCTURE DEFICIENCY SKETCH

Purpose

To record the extent of substructure deterioration.

What to Document

Document any erosion of concrete, missing masonry, broken or rotten timber lagging, holes in sheet piling, and any other form of deterioration which cannot be accurately described in the condition comments.

How to Document

Sketch location and size of deterioration and note the type, showing all three dimensions. See figure 4D.12.1 for a sample sketch.
4D.1 - PIER INTRODUCTION

This is a substructure supporting spans of a multi-span structure at an intermediate location between abutments. It should support the superstructure with minimal obstruction to the flow of traffic or water. Besides its own weight, the pier must carry vertical and horizontal forces transmitted by the ends of two superstructure spans, and restrain any span movement. A pier must also withstand impact from vehicular collision or from water-borne traffic and impact from ice and water flow.
Pier and Span Numbering

Each pier is associated with the end of a span looking in the direction of orientation. Refer to figure 4D.1.1. All elements of a pier are rated for the span associated with that pier. The pier elements for the last span of a bridge are all rated 8 – not applicable because the substructure at the end of the last span of a bridge is an abutment. The only exception is a ramp bridge that connects two mainline bridges with the end of the last span supported by a pier. Note that pin and hanger assemblies are considered piers.

PIER AND SPAN NUMBERING
Figure 4D.1.1
TYPICAL PIER TYPES
See figures 4D.1.2 through 4D.1.20

TYPICAL FRAME PIER
Figure 4D.1.2

TYPICAL PI PIER
Figure 4D.1.3
TYPICAL HAMMERHEAD PIER
Figure 4D.1.4

TYPICAL DOUBLE HAMMERHEAD PIER
Figure 4D.1.5
TYPICAL COLUMN PIER WITH STRUT
Figure 4D.1.6

TYPICAL COLUMN PIER WITH CRASHWALL
Figure 4D.1.7
COLUMN PIER WITH STRUT
Figure 4D.1.8

TYPICAL COLUMN PIER WITH CRASHWALL
Figure 4D.1.9
TWO-COLUMN PIER WITH WEB WALL
Figure 4D.1.10

PIER COLUMN WITH WEB WALL
Figure 4D.1.11
Note: Driven pilings may be steel, timber or concrete.

TYPICAL PILE BENT PIER
Figure 4D.1.14

TYPICAL STEEL FRAME PIER
Figure 4D.1.15
TYPICAL STEEL BENT PIER
Figure 4D.1.16

TYPICAL STEEL COLUMN
Figure 4D.1.17
The following elements are rated 8:
- Bearing, anchor bolts, pads
- Pedestals
- Top of pier cap or beam (unless construction joint is present at top of pier stem)
- Pier columns
- Cap beam

TYPICAL CLOSED MULTI-CELL BOX CULVERT
Figure 4D.1.18

The following elements are rated 8:
- Bearing, anchor bolts, pads
- Pedestals
- Top of pier cap or beam (unless construction joint is present at top of pier stem)
- Pier columns
- Cap beam

TYPICAL MULTI-SPAN CONCRETE FRAME
Figure 4D.1.19
Rate pin and hanger assembly as Bearing, Anchor Bolts, and Pads.

At pin and hanger pier, rate the following 8:
- Pedestals
- Top of pier cap or beam
- Pier stem
- Cap beam
- Pier columns
- Footings
- Piles

**TYPICAL PIN AND HANGER**

*Figure 4D.1.20*
Typical Materials

See ‘General Bridge Material Deficiencies’ under Chapter 3.6.

Notes On Multi-Level Piers

The multi-level pier is found primarily at interchanges with multi-level structures. It can be either steel or concrete or some combination of both materials. The lower portion is integral with the upper portion and must be inspected as a whole unit. Each superstructure carried by this frame may have upper and lower level BINs or entirely separate BINs.

The following procedure should be observed when inspecting each superstructure level and its supporting substructure:

Inspect all portions of the vertical elements that support the structure. When inspecting the pier columns of the upper structure, the condition of the columns in the lower portion also has to be considered. Include lower cap beams that are connected to columns even though they are not part of the superstructure being inspected.

Pier Elements

Depending on the type, the following elements are to be inspected and rated as part of the pier:

- BEARINGS, ANCHOR BOLTS, PADS
- PEDESTALS
- TOP OF PIER CAP OR BEAM
- SOLID PIER STEM
- CAP BEAM
- PIER COLUMNS
- FOOTINGS
- EROSION OR SCOUR
- PILES
- PIER PROTECTION

For piers in water, refer to Appendix D – Underwater Inspection for further inspection procedures.

Ramp bridges connected to mainline bridges are oriented such that the beginning of the ramp bridge is at the mainline bridge. If the ramp bridge is framed directly into the primary members of the mainline bridge, the components supporting the beginning of the ramp bridge are inspected as primary members for the ramp bridge. If the beginning of the ramp bridge is supported by a pier that also supports a part of the mainline bridge, the bearings, pedestals and top of pier cap supporting the ramp structure should be rated as begin abutment bearings and bridge seat and pedestals for the ramp bridge even though there is no beginning abutment. When this is done, a remark needs to be provided.

When inspecting a pier on the mainline structure of a bridge that also supports a ramp structure, inspection should include the part supporting both the mainline and ramp structures. See figure 4D.1.21. All elements supporting the mainline structure should be included in the rating for the pier of the mainline structure. The cap beam, columns, footings and piles supporting both the main bridge and the ramp bridge should be inspected with the main bridge. If mainline pier deficiencies adversely affect the ramp bridge, cross-referenced remarks on the mainline and ramp inspection reports are necessary.
RAMP BRIDGE

Figure 4D.1.21
4D.2 - BEARINGS, ANCHOR BOLTS & PADS

Refer to Chapter 4, Section C.3 for a complete description of the function and types of Typical Bearings as well as What To Look For.

What To Rate

Rate the condition of the bearing pads, bearings, and anchor bolts at a pier that is at the end of a span or at the end of a cantilever span. This rating should reflect the condition of the worst bearing rated. Do not average conditions of all the bearings. For a pier that supports two sets of bearings, the bearing, anchor bolts and pads for both spans should be included in the same rating (see figure 4D.2.1). The exception to this is the case where a pier supports both a main bridge and a ramp bridge (see figure 4D.1.21).

Pin and Hanger connections are commonly used at expansion ends of suspended spans. Though not placed above any substructure, they function as bearings, in that they accommodate rotation and translation and also transmit vertical loads from the suspended span to the adjacent cantilever span. Pin and hangers are rated under the pier at the end of span (looking in the direction of orientation) they are attached to. All other pier elements are rated 8 – not applicable for this span (see figure 4D.1.20).

Hangers may be fracture-critical (where a single fracture can lead to catastrophic collapse) or redundant, depending on the number of hangers supporting a member and the redundancy of the supported members. Refer to Appendix C for more information on inspecting fracture-critical elements.

All hangers are susceptible to failure by cracking because they are subjected to both direct tensile and bending stresses. Hangers with only one pin (either top or bottom) are especially prone to cracking failure. Hanger stresses are increased by corrosion at the pin/hanger interface by stress-risers (such as deep corrosion pits, notches, and tack welds) and by section loss from corrosion. These conditions should be observed and documented during inspection. Each hanger should be thoroughly inspected for any evidence of cracks or corrosion. Where hangers are decorated with ornamental covers, they must be removed for inspection of the pins and hangers. Alignment of the suspended member should be checked to ensure that hangers are not subjected to racking forces, and that any wind locks or guide plates are functioning properly. Frozen pin and hanger connections do not function as designed and should be rated no higher than 3. Cracks should be reported immediately. All problems should be documented by photographs, sketches, and comments. Look for misalignment of stringers and measure gaps.

EXCEPTIONS: Where stringers frame directly into the web of cap beams without seated connections, rate bearing, anchor bolts and pads 8.

These elements are also rated 8 for multi-span concrete arches, culverts, pipes, concrete frames, and some steel frame bridges.

Bridge bearing stools are extensions of beams or girders that compensate for beam/girder depth differences between two adjacent spans at a pier. The bearing stools transmit end reactions to supporting sole plates and bearing assemblies. The bearing stools are not inspected as bearings, but rather as primary members. Under certain circumstances, these details require special emphasis (100% hands-on) inspection. See Appendix C for more information.
Two sets of bearings at a pier

Figure 4D.2.1

Rating Examples

When rating condition of the bearing system consider the effect of the condition on the bearing's function as well as its condition. To function properly, a bearing system must support (or anchor) the superstructure and provide for end-of-span movement. If not functioning as designed, excessive stresses may be induced in the superstructure or substructure that could shorten the usable life. Improper positioning may lead to serious consequences. Additional superstructure movement may cause damage to other elements, such as backwalls, or may cause extension of the bearing beyond safe limits.

7 - Bearings are in new or like-new condition, in proper position for the ambient temperature.

5 - Minor deterioration, but still allow movement, if required. Bearings should be reasonably close to proper position for the ambient temperature.

3 - Serious deterioration or deformation of the bearings, improper positioning of the bearings, and/or frozen bearings. Secondary effects of frozen bearings, such as sheared anchor bolts and/or cracked pedestals may be evident.

1 - Bearing is completely disintegrated and inoperative or has failed, or is extended in a position no longer providing support.
Figure 4D.2.2 – Rate 7
All bearings at the pier are in like-new, excellent condition.

Figure 4D2.3 – Rate 5
The rocker bearing of the fascia girder has a minor amount of corrosion that is not restricting bearing movement. The remaining bearings show no sign of deterioration.
The two bearings are heavily rusted around the base plates and pins. There is no evidence of movement; the bearings are probably frozen.

The rocker bearing is very heavily corroded. This bearing is clearly unable to accommodate superstructure deflection or allow expansion or contraction. The bearing still provides support of the superstructure.
Figure 4D.2.6 – Rate 1
There is a crack in the hanger portion of the pin and hanger assembly. The pin and hanger is at the end of span 3. Rate the pier bearings for span 3.

Figure 4D.2.7 – Rate 1
Both bearings are corroded and severely overextended in the same direction. Further movement toward the right threatens settlement or collapse of the structure.
4D.3 - PEDESTALS

The pedestal's function is to support the bearings, transfer loads to the substructure and to make up any differences in elevation between the top of the cap beam or pier stem and the bottom of bearing.

What To Rate

For raised pedestals, rate the entire pedestal, including the sides. For piers without raised pedestals, rate the condition of the area under the bearings or superstructure elements (i.e., beams or girders) including the horizontal and the vertical surfaces immediately next to the bearing which represents the point of load transfer between the bearing (or superstructure) and supporting substructure. Base the rating on the condition of the worst pedestal. Comments should include the condition of all pedestals.

Typical Pedestals

Some typical pier pedestals are illustrated in figures 4D.3.1 and 4D.3.2.
What To Look For

An important consideration is how well the pedestal supports the superstructure.

For concrete pedestals look for such deterioration as spalling (particularly if resulting in loss of bearing area) or map cracking. Pedestal deterioration usually results from poor deck drainage and the presence of deicing salts. Also investigate for larger cracks, such as stress cracks (pedestal failure), shrinkage cracks and cracks caused by superstructure movement or pavement shove. For stepped pedestals check for cracking at the horizontal and vertical interface. Also, check pedestals for dampness. Look for debris buildup (soil, leaves, bird droppings, etc.) on top of the pedestals that can trap moisture and cause deterioration.

For steel pedestals look for section loss due to corrosion, and check connections for cracks, and the accumulation of debris.
Rating Examples

7 - New or like-new condition.

5 - The pedestal may have minor deterioration, such as minor map cracking without delamination, possible hairline shrinkage or temperature cracks (not stress cracks), and/or minor spalling or scaling that does not involve the area under the masonry plate of the bearing.

3 - There may be heavy map cracking and efflorescence with indications of hollowness or heavy spalling or scaling that involves most or all of the pedestal. A 3 rating would also be used for pedestals having significant debris buildup and/or spalling that result in the loss of bearing area. Working stress cracks caused by compressive overstress (splitting) or induced by frozen bearings that have not yet progressed to a critical state would also warrant a 3 rating.

1 - This represents deterioration or a stress crack so severe that failure of a pedestal has occurred or is imminent.

Figure 4D.3.3 – Rate 7
The recently replaced pedestal is now in excellent condition.
Figure 4D.3.4 – Rate 4
The right face of the pedestal exhibits a wide diagonal crack. No delaminations are present and the full bearing area remains solid.

Figure 4D.3.5 – Rate 3
The pedestal is severely spalled and delaminated with solid reinforcement exposed.
Figure 4D.3.6 – Rate 2
The pedestal is seriously deteriorated with broken confinement reinforcement and a vertical crack. Spalls and hollow sounding delaminations are present on the other faces.

Figure 4D.3.7 – Rate 1
The bearing sits directly on the pier cap. The portion rated as the pedestal previously failed causing the bearing to lose support. A temporary steel H-pile was set against the concrete column and it now provides the bearing support for the beam. Do not consider the temporary H-pile in the rating.
4D.4 - TOP OF PIER CAP OR BEAM

This is the area between and around pedestals.

What To Rate

Rate the condition of the top of cap beam (or pier cap) between pedestals. For solid piers, rate the top of the stem between pedestals. Do not rate the tops of crash walls or column struts. Where a floorbeam sits directly on top of a cap beam, rate the condition of the interface between the floorbeam and cap beam. For rigid frames and multi-cell box culverts rate the construction joint between the pier and slab. If there is no construction joint, rate 8.

What To Look For

Check for collection of debris (soil, leaves, bird droppings, etc.) and drainage from the deck onto the cap surface. Debris traps moisture that may lead to corrosion of structural steel members, corrosion of rebars and disintegration of the concrete surface. For concrete pier caps, look for signs of deterioration (spalling, map cracking, efflorescence, and presence of de-icing salts). Also, check for stress cracks or cracks caused by movement of the superstructure. For steel pier caps, check for loss of section due to rusting. For masonry, look for loose stone, loss of mortar in joints, and breakup of stone. The condition of the top of pier cap or beam may indicate the condition of the deck joint above if it was designed as watertight.

Rating Examples

7 - New or like new condition. No debris.

5 - Some deterioration of the top of the pier cap and/or presence of a minor amount of debris.

3 - The top of pier cap is heavily deteriorated and/or has a large amount of wet debris.

1 - The top of pier cap is extensively deteriorated and possibly also covered with a large amount of wet debris.
Figure 4D.4.1 – Rate 5  
The top of cap is in like new condition with minor accumulation of debris.

Figure 4D.4.2 – Rate 4  
The edge of the top of pier cap exhibits deep spalling with exposed reinforcement. The remaining top of pier cap is solid when struck.
Figure 4D.4.3 – Rate 3
The top of pier cap is heavily scaled with a large amount of debris and vegetative growth.

Figure 4D.4.4 – Rate 1
The top of pier cap is heavily spalled across the full width in multiple bays. Exposed reinforcement is rusting. In this bay the concrete is soft, saturated and easily penetrated by the chipping hammer.
4D.5 - SOLID PIER STEM

This is either the stem of a solid pier, or crash wall of a frame pier that resists forces from the superstructure and transfers those forces to the foundation.

What To Rate

Rate the condition of the pier stem, the crash wall below the column of a frame or column pier, the vertical portion of the piers of multi-span arches, and the wall between cells of multi-cell box culverts. Include the condition of the top horizontal surface for crash walls.

Typical Stems

For typical types see figures 4D.5.1 and 4D.5.2.
What To Look For

Look for typical signs of concrete deterioration: map cracking, leaching, spalling, cracks, and hollow or dead-sounding concrete. For masonry stems, look for loose or missing stones and deteriorating mortar joints. Look for impact and fire damage. For timber piers look for splitting, crushing, decay, insect damage and fire damage. Examine all stems for lack of stability indicated by tilting or lateral or vertical movement. Defects and working cracks should be documented in terms of length, width, and location to monitor the progress of these conditions. When rating a solid pier stem, it is important to check for proper vertical alignment and its ability to support superstructure loads.
Rating Examples

7 - Use for a stem in a new or like-new condition.

5 - Indicates minor deterioration, such as map cracking with efflorescence covering up to about 25% of the stem surface, but hammer-sounding would reveal little or no evidence of hollowness. Some spalling may be occurring, but would not cover more than about 10% of the stem nor would it encroach on the top of pier cap or pedestals.

3 - Deterioration would be extensive and characterized by wide-spread map cracking, efflorescence, spalling and/or scaling. There may be structural cracks that are active. If there is evidence of significant movement whether or not the stem is deteriorated, a 3 rating would be used to reflect the stem’s reduced ability to properly support the superstructure.

1 - Deterioration or movement is so severe that failure has occurred or is imminent.

Figure 4D.5.3 – Rate 7
The crash wall, rated under the solid pier stem, is in like-new condition.
The pier has minor scaling at the nose and localized mapcracking elsewhere. Rust stains are from the leaking deck joint. The concrete sounds solid when struck with a hammer.

There are several spalls exposing reinforcement. Sounding indicates multiple delaminations on all faces. The exposed reinforcement has little if any section loss.
Figure 4D.5.6 – Rate 3
The pier stem has extensive spalling, map cracking efflorescence and delaminations. The location of the deterioration with respect to the top of pier cap and bearing area is a consideration in rating the stem.

Figure 4D.5.7 – Rate 2
The minimally reinforced concrete pier stem is severely spalled, saturated and punky. The concrete is easily removed by hand.
This is generally the uppermost portion of a pier bent. The cap beam transfers concentrated loads from the superstructure to pier columns or stem. Sometimes the cap beam also helps hold pier columns in proper position relative to each other.

**What To Rate**

The cap beam or the strut between columns including the condition of the top surface for struts.

**Typical Cap Beams**

For typical cap beams see figure 4D.6.1 and 4D.6.2.
What To Look For

**Concrete:** Most concrete cap beams have considerable reinforcement in the top face, bottom face, or both. Since this steel has only minimal cover, it is susceptible to corrosion damage from water, salt, and debris falling through deck joints. Early stages of corrosion damage are cracking and delamination, with spalling in the final stage. Check for rebar corrosion, loss of bond, and characteristics of fire damage such as discoloration, heavy concrete granulation and chalking. Strike concrete cap beams with a hammer to find areas of delamination or unsound concrete. The concrete must also be checked for map cracks, stress cracks, and efflorescence. Review plan set to determine how spalls or delaminations affect reinforcement lap capacity.

**Steel:** Steel cap beams must be checked for section loss, buckling, distortion, and connections. Refer to Appendix C for more detailed discussion on the inspection of fracture critical and non-redundant bridge components. For steel box girders, check for accumulation of debris or water. Any significant accumulation should be noted in the report.

**Timber:** Check timber cap beams for splitting, crushing, decay and insect damage. Connections are likely locations for deterioration such as splitting or rottting. They should also be checked for tightness and hardware condition.
Rating Examples

When rating cap beam condition, consider structural action of the member, as well as the extent of deterioration compared to the cap beam dimensions.

7 - New or near-new condition.

5 - For concrete cap beams, map cracking and efflorescence may be evident on the faces and bottom of the cap, but not exceeding about 25% of the cap, and hammer sounding indicates little or no delamination. For steel, corrosion may be present, but if so, section loss in high stress areas is minor. A timber cap beam may show some checking and minor splitting with some discoloration, but hammer tapping and checking with an awl show little or no hollowness or decay.

3 - Deterioration of concrete would be significant and characterized by wide-spread map cracking, efflorescence, spalling and/or scaling. Corroding rebars may be delaminating the bottom cover. Significant debonding and/or reinforcement section loss is present. There may also be active structural cracks. Steel cap beams would have significant section loss in high stress areas and may have cracks or local buckling. Timber caps would have hollow areas and awl penetration would show significant decay. There may also be heavy checking or splitting.

1 - Deterioration or impact damage is so severe that structural integrity is in doubt. Failure may have occurred or may be imminent.

Figure 4D.6.3 – Rate 7
Figure 4D.6.3 shows a cap beam with no indications of deterioration.
The steel cap beam paint is beginning to fail. Minor corrosion has formed but section loss is negligible. Pack rust prying of the plates is beginning to develop.

The bottom of the cap beam exhibits map cracking and a small spall. Rust stains indicate corroded reinforcement within and striking with a hammer reveals localized delaminations.
Shown is a cap beam with a significant amount of spalling, delaminations and corroded reinforcement on one face and the top of cap. Debonding is insignificant but there are areas of hollow sounding core concrete. The negative moment capacity may be affected.

The underside of the pier cap beam is deeply spalled with exposed, rusted reinforcement. Three out of 5 exposed main reinforcement bars are partially debonded and many of the exposed stirrups are broken. The core concrete is sound and solid.
Figure 4D.6.7 – Rate 2
Extensive spalling of the cantilevered cap beam extends up to 2" behind several hoops on both vertical faces and the entire bottom mat of reinforcement. The exposed reinforcement is significantly corroded.

Figure 4D.6.8 – Rate 1
The concrete pier cap has an extreme shear crack and documented short term movement. The temporary repairs and in-place shoring are not considered in the pier cap rating.
4D.7 - PIER COLUMNS

These are the vertical members resisting bending and compression forces and transferring them to the foundation.

What To Rate

The rating should reflect the condition of the worst column in the pier and comments should include condition of all columns. For steel or timber pile bents, consider the bracing condition in determining the column rating. At a double column pier, consider the pier column for both spans in column rating for the pier (see figure 4D.7.2).

Typical Pier Columns

See figure 4D.7.1 and 4D.7.2 for typical types of pier columns.
What To Look For

**General:** All pier columns should be examined for tilting, settlement, overstress due to load, or impact damage. Check for deterioration, especially near the waterline, at the ground line, and where the columns are exposed to roadway drainage, either from leaking deck joints or from vehicle splash. For brick-faced or shotcreted piers, look beyond the facing for evidence of leakage or cracks. For pier columns with guiderail protection, document the railing condition and effectiveness. However, do not reflect the condition of the rail protection in the column rating.
**Concrete:** Look for map cracking, efflorescence, cracks and spalling. Check especially for vertical cracks caused by frozen bearings or compression failure. All concrete should be sounded with a hammer to check for delaminations or soft concrete. Check also for bonding loss and rebar section loss.

**Steel:** Look for section loss of members and connections due to rust, including batten plates and cross bracing. Also check for local and column buckling, and cracks. In particular check the column base. If present, include the condition of column base plate anchor bolts.

**Timber:** Check for splitting, crushing, decay and insect damage. Connection hardware and connection areas are frequent problems. Look for evidence of fire damage.

**Rating Examples**

In determining the numerical condition of a column, consider the degree and extent of deterioration as compared with the column dimensions. Judge the condition as compared to what the column was like when new.

7 - New or near-new condition.

5 - For concrete columns, map cracking and efflorescence may be evident, but not exceeding about 25% of the column surface and hammer sounding indicates little or no delamination. For steel, corrosion may be present, but section loss in high stress areas is minor. A timber column may show some checking and minor splitting with some discoloration, but hammer tapping and checking with an awl show little or no hollowness or decay.

3 - Deterioration of concrete would be significant and characterized by wide-spread map cracking, efflorescence, spalling and/or scaling. Corroding rebars may be delaminating the rebar cover. Significant debonding and/or loss of section of reinforcement may be present. There may also be active structural cracks. Steel columns would have significant section loss in high stress areas and may have cracks, local buckling or web crippling. Timber columns would have hollow areas and awl penetration would show significant decay. There may also be heavy checking or splitting. If there is evidence of significant movement whether or not the column is deteriorated, a 3 rating would be used to reflect the column’s compromised ability to properly support the superstructure.

1 - Deterioration or impact damage is so severe that structural integrity is in doubt. Failure may have occurred or may be imminent.
Figure 4D.7.3 – Rate 7
The two adjacent steel columns show no signs of deterioration. Note that the columns support separate spans, but are rated together. The rating is for the span that is before the pier, looking in the direction of orientation.

Figure 4D.7.4 – Rate 4
The timber pier column exhibits vertical splits above the water line. The top of the column is hollow sounding and has minor decay.
The concrete column has major deterioration. Spalls, exposed and corroded reinforcement, delaminations and map cracking are evident on 3 out of 4 faces.

Heavy deterioration of the transverse bracing compromises the lateral strength and stability of the pier.
Nearly half of the column’s horizontal tie bars are corroded through thus severely reducing confinement of the corroded and debonded vertical reinforcement. These conditions have reduced the column’s load capacity. Do not include the temporary columns in the rating.

The concrete column is destroyed. The steel columns are temporary supports and are not considered in rating the column.
4D.8 - FOOTINGS

These are designed to transmit substructure loads to the subgrade material or piles, and to maintain the substructure at a particular alignment and grade.

What To Rate

Rate the condition of the pier footing and its ability to function properly. Also include any foundation material deficiencies that may be causing distress to the pier or superstructure.

Typical Footings

Footings are either continuous or individual. The individual footings could be spread or on piles. When a pier stem or column is constructed without a distinct footing, the area where the stem or column meets the subgrade is rated as a footing.

What To Look For

Footings are usually visible only after erosion or scour has removed significant embankment material. When exposed, check for signs of deterioration, such as cracking, leaching, spalling, and hollow-sounding concrete. Also check for signs of distress in the form of large cracks or splits, and document them for future reference. At locations where the footing is not visible, check for evidence of settlement or other movement; for example, if areas over footings are paved, these should be inspected for cracks following the periphery of the footing. Presence of such cracks may suggest that the spread footing had settled or rotated. For unpaved areas, lines in the soil could suggest the same.

Vertical movement can occur as uniform or differential settlement. Uniform settlement of all bridge substructure units has little effect on the structure. Differential settlement, however, is the more common form, and may produce serious distress. The most common causes of vertical movement are soil bearing failure, soil consolidation, scour, or deterioration of footing material. A hand level or plumbline can be used to check for differential settlement.

If aggradation or repair of subgrade prevents observation of previously noted conditions, the conditions and rating previously provided should be carried forward. In such cases, document why the information is being carried forward and the original observation date.
Rating Examples

9 - This is the most frequently used rating. This code ("Unknown") is used when the footing is covered, with no signs of movement or settlement.

7 - Use when the footing is visible, functioning properly, and in a like-new condition.

5 - Indicates minor deterioration, such as minor cracking or spalling.

3 - Indicates significant movement of a substructure. Significant undermining of spread footing is causing distress to the substructure or superstructure. A footing significantly deteriorated by cracking or heavy spalling is also rated 3.

1 - Indicates a failed substructure or a footing that is undermined, cracked or spalled to such an extent that it can no longer transfer load from substructure to subgrade material or piles.

Photographic rating examples for pier footings are similar to those of abutment footings. For examples see Chapter 4, Section C.10.
**4D.9 - EROSION OR SCOUR**

**What To Rate**

Two separate conditions are examined, depending on whether the pier is located in water. For those remote from bodies of water (and, thus not exposed to stream scour), this element is used to evaluate the erosion of the embankment material (and covering) next to or under the pier footing. Erosion is the wearing away of soil by flowing water. As used here, soil includes embankment covering as well as the embankment material. Flowing water here refers to runoff from the bridge superstructure or approach roadway rather than the stream.

For piers at the water's edge or founded in water (vulnerable to scour), this element is used to evaluate the extent of scour of the foundation material above, around and under the footings. Scour is erosion of a riverbed area caused by stream flow. Scour must be documented in accord with Chapter 4, Section B. See also the description of underwater inspection in Appendix D.

For more information about scour caused by streams, see the introduction to Chapter 4, Section A.

**What To Look For**

**Erosion:** Disturbance or loss of embankment covering material and the embankment material above, around, and below the footing. An uneven surface on block paving may indicate loss of embankment material below. Other signs include soil marks at the face of pier stems or columns or other irregularities in the embankment surface. Comparison of existing conditions against earlier photographs often quickly indicates material loss or movement.

**Scour:** Loss of material from a streambed in the immediate vicinity of a pier resulting from stream flow. Included in the rating for this element is the loss of material above, around, and under the footing. The three types of scour that affect bridge substructures are general scour, contraction scour, and local scour. All three types of scour can seriously affect the performance of a pier. For additional information, refer to the introduction to Stream Channel, Chapter 4, Section A.

Careful comparison of information acquired over the course of several bridge inspections at the piers is one of the best ways to determine how much scour has occurred. Determining the maximum extent of scour is difficult because it occurs during a flood and its true extent may be masked by sediment that refills the hole when flood waters recede. The inspector should use a rod where possible to probe loose sediments deposited along the bridge substructures. If the sediment is finer than the typical bed material, or if it is easily penetrated by the rod, this means that the present sediment has accumulated in the scour hole, and local scour is more severe than indicated by channel profile readings along the substructures. Details of required scour documentation are given in Chapter 4, Section B.
Rating Examples

7 - Dropline or rod readings show no scour, or for piers remote from water, the embankment and its coverings are in "like-new" condition.

5 - Minor erosion or scour has occurred, such as displacement or loss of much of the block paving, or loss of embankment or streambed material where the top of the footing is partly exposed.

3 - Serious erosion or scour has occurred. This would include loss of embankment material including covering such as block paving or streambed material, to the extent that a substantial length of footing is undermined, but piles are present.

1 - Erosion or scour has progressed to the point where pier failure has occurred or is imminent. This may include extensive undermining of a footing without piles, where the presence of piles is unknown, or with piles of questionable condition, even if the pier has not yet failed.

Note: The presence and expected condition of piles are important factors to consider in rating erosion and scour. Particularly for older bridges, the indication of piles on "as built" plans should be the only acceptable evidence, other than direct observation, that piles exist.

Figure 4D.8.1 – Rate 5
Minor scour has exposed the tops of the individual footings which are set on piles.
Figure 4D.8.1 – Rate 4
Runoff from the adjacent highway has caused erosion of the concrete pavers on one side of the pier.

Figure 4D.8.2 – Rate 4
Stream bed degradation has exposed the spread footing’s vertical faces to various depths up to 18 inches. The plan set indicates the footing is 3 feet thick.
Figure 4D.8.3 – Rate 3
The concrete footing at the end face of the pier was recently exposed for its full length and height. Undermining has revealed the piles. The concrete footing at the begin face is buried.

Figure 4D.8.3 – Rate 2
The nose of the pier spread footing has broken and settled due to undermining. The pier stem has not settled and appears stable.
4D.10 - PILES

Piles are generally used to transfer loads from the bridge substructure and footing to the underlying soil or rock. For pile bents, the piles are the portions below existing ground or mudline.

What To Rate

Footings on piles: Rate pile condition and ability to function properly.

Pile Bent: Rate piles based on observed condition at existing ground or mudline if a deficiency is observed. Otherwise, rate 9 – Unknown.

What To Look For

Piles are generally not visible, but if they can be seen, this usually indicates a serious structural defect that must be investigated. For deterioration related only to the piles, look for the following:

**Steel:** Look for loss of section due to corrosion, buckling, web crippling, and for improper placement and/or alignment.

**Concrete:** Look for concrete deterioration, such as cracking, splitting, spalling, or efflorescence.

**Wood:** Wood piles, like the other types, are generally not visible, but if exposed (particularly above water) are highly susceptible to rot, marine borer and insect attack. Use a hammer, awl, or knife to check for rot.

If the piles are not visible, the inspector can stand on the ground above a pile-supported footing and if strong vibrations occur when traffic passes above, this suggests that soil around the piles' upper portion has lost some fines and the piles now act as columns instead of piles.

If aggradation or repair of subgrade prevents current observation of previously noted conditions, the conditions and rating previously provided should be carried forward. In such cases, document why the information is being carried forward and the original observation date.

Rating Examples

9 - Unknown. This is a frequently used rating. Use if the inspector knows that piles exist, but are not visible, or if the inspector is not sure if piles exist.

8 - Not Applicable. Use this rating when the inspector is certain that piles do not exist.

7 - Use when piles are visible and are in like-new condition.

5 - Minor deterioration, but piles are functioning as designed. Use for steel piles with heavy rust but little section loss, or for concrete piles with minor spalling or cracking but basically solid.

3 - Serious deterioration; may involve significant loss of section in a steel pile, splitting or spalling in a concrete pile, or rotting of a timber pile.

1 - Extreme condition; one or more piles either critically deteriorated or completely failed.
4D.11 - PIER RECOMMENDATION

What To Rate

This is a one number rating used to describe the pier's overall condition and functional capability on an individual span basis. This recommendation will normally reflect the scoring of the individual elements but it does not necessarily have to be the lowest of these ratings.

Ratings

The inspector evaluates the entire system comprising "Pier Elements" by using the rating number that best describes his opinion of the system's condition and ability to function.

8 - NOT APPLICABLE

7 - NEW CONDITION

6 - Used to shade between 5 and 7

5 - MINOR DETERIORATION BUT FUNCTIONING AS ORIGINALY DESIGNED

4 - Used to shade between 3 and 5

3 - SERIOUS DETERIORATION OR NOT FUNCTIONING AS ORIGINALY DESIGNED

2 - Used to shade between a rate of 1 and 3

1 - TOTALLY DETERIORATED OR IN FAILED CONDITION
4D.12 - SUBSTRUCTURE DEFICIENCY SKETCH

**Purpose**

To record the extent of substructure deterioration under water.

**What to Document**

Document any erosion of concrete, missing masonry, broken or rotten timber lagging, holes in sheet piling, and any other form of deterioration which cannot be accurately described in the condition comments.

**How to Document**

Sketch location and size of deterioration and note the type, showing all three dimensions. See figure 4D.12.1 for a sample sketch.
SAMPLE SUBSTRUCTURE DEFICIENCY SKETCH
Figure 4D.12.1
This chapter includes the following rating elements:

5.1 - DRAINAGE
5.2 - EMBANKMENT
5.3 - SETTLEMENT
5.4 - EROSION
5.5 - PAVEMENT
5.6 - GUIDE RAILING

The elements on each approach are rated separately, but only the lower ratings are entered on the inspection form. Therefore, the rating is based on the condition of the worst element of the group (do not average the conditions of the elements for the rating).

Approach Length Definition

Bridge approach length is the transitional distance from a typical highway section to a bridge. It is not a fixed distance, and each approach inspection element may have its own unique length. These approach lengths will probably vary from bridge to bridge depending on bridge design, location, and the roadway carried. An approach length, for each inspection element, should be based upon its original design function and its influence on the bridge. This chapter gives general guidance on acceptable length of each approach element to be inspected, but the inspector should decide the actual appropriate length at the site.
5.1 - DRAINAGE

What To Rate

Rate the effectiveness of the approach drainage system in preventing water from running onto the bridge, and in removing water from the bridge if scuppers are not present, and in removing water from the approach surface.

What To Look For

Normally, approaches are drained by crowning the roadway and sloping the shoulders to side ditches, gutters, catch basins, or embankment slopes.

Check for:
- Lack of crown in approach pavement.
- Low areas in pavement that pond water (causing hydroplaning and pavement deterioration).
- Eroded ditches or gutters.
- Gutters filled with debris.
- Clogged catch basin inlet grates.
- Sand and debris deposits in catch basin and plugged outlet pipes.
- Sand buildup along shoulder edge at guiderail posts.
- Water running onto the high end of the bridge from a continuous grade.
- Low areas along shoulders that pond water.
- Areas that concentrate water causing erosion or diverting water onto bridge abutments and wingwalls.
- Broken, missing or misaligned curb sections.
- Lack of drainage structures, ditches or gutters to remove collected water or prevent embankment erosion.

Approach Length Guidelines For Drainage

Things to consider:
- Length of curb from abutment to end of curb at the embankment slope gutter.
- Length from abutment to drainage structure inlet.
- Length of approach slab plus pavement relief joint.
- Length of approach railing.
- In the absence of curbs, approach slabs, or drainage structures, the inspector determines a suitable approach length.
Rating Examples

The numerical rating should indicate the condition and effectiveness of the approach drainage system. Consider its effects on vehicular traffic, pavement, embankment, abutments, or the bridge structure.

7 - Indicates a fully effective drainage system with no deficiencies.

5 - Indicates a drainage system with minor deficiencies not causing a serious problem. This could include moderate sand and debris buildup along curb lines, gutters, and guiderails and in catch basins and inlet grates.

3 - Indicates a drainage system with major deficiencies causing serious problems. This could include deterioration of pavement and shoulders, embankment erosion, deterioration of bridge abutment elements and bridge structure elements.

1 - Indicates a drainage system that would allow ponding of water on the approach roadway and possible contribution to ponding on the bridge deck. The approach drainage system may also be causing severe erosion of the embankment and possibly causing severe deterioration to the abutment and/or bridge superstructure.

Figure 5.1.1 – Rate 6
The pavement crown and roadway grade provide positive drainage of the bridge. Shoulders and curb faces are relatively free of debris. Some minor sand buildup exists at the left approach curb face where it transitions behind the guide railing; this causes no significant problems.
Figure 5.1.2 – Rate 3
Sections of the approach curb are missing or displaced. Drainage from the bridge is no longer channeled to the embankment’s stone lined gutter. Drainage through the missing and misaligned curb sections has formed erosion gullies on the embankment.

Figure 5.1.3 – Rate 1
The approach catch basin is 100% clogged with dirt and debris which causes ponding of water on the approach roadway and possible contribution to ponding on the bridge deck.
5.2 - EMBANKMENT

What To Rate

Rate the approach embankment for settlement and/or sloughing of the side slopes. Do not include settlement of approach pavement or subgrade.

What To Look For

Stability of the embankment is the main consideration. Settlement results in a convex appearance of the side slope and abrupt changes in side slopes suggest failures. Check for cracks in soil perpendicular to the slope indicating imminent failure. Guiderail posts out of plumb and leaning outward down the slope may indicate embankment settlement or slope failure. Vertical displacement of guiderail and posts may also indicate similar slope deficiencies. Investigate further.

Settlement and failure of an approach embankment is shown in Figure 5.2.1.
Approach Length Guidelines For Embankment

Use length from bridge abutment to a location of 50 to 80 feet beyond the end of the wingwalls.

Rating Examples

7 - No signs of distress.

5 - Some settlement may be occurring or the presence of a few soil cracks perpendicular to the slope may indicate minor shifting of embankment.

3 - Sloughing indicating soil shear failure, but not in close proximity to the roadway.

1 - Severe sloughing that is causing significant loss of embankment support for the roadway.

A rating of 8 will very rarely occur. Even for a roadway in an earth or rock cut, there will be some depth of embankment fill.

A 9 rating should be used only when the embankment cannot be visually or physically inspected. A 9 rating requires a comment in the inspection report.

Figure 5.2.2 – Rate 7
The guiderail is lightly scraped and the posts are leaning due to snow removal operations. This condition is not a result of embankment settlement. The embankment shows no sign of distress.
Localized embankment failure exists outside of the roadway. Excessive wetness of soil appears to have caused sloughing of soil.

Erosion of the adjacent stream bed weakened the embankment. Consequently, severe sloughing has caused significant loss of embankment support and collapse of the roadway.
5.3 - SETTLEMENT

What To Rate

Rate any settlement of the approach pavement subgrade and the smoothness of transition between the approach roadway and bridge. The rating should include settlement of both pavement and shoulders but should not include sidewalks (this should be rated under the Sidewalk element). Pavement heave that results in the approach pavement higher than the bridge deck should be rated as settlement.

What To Look For

Check riding quality of the transition by driving over the bridge. A smooth transition will minimize impact and vibration forces that contribute to deck and wearing surface deterioration. Look for cracking and breaking of concrete approach slabs that might be due to settlement of the subgrade. Asphalt patches used to ramp a difference in elevation between the approach and bridge should be rated as to their ability to reduce the impact caused by difference in elevation. Observe vehicles entering and exiting the bridge for any excessive vertical movement or bounce. Sight along the approach pavement markings, which may highlight a dip or settlement. A straight edge laid across the bridge abutment longitudinally over the approach pavement is useful in observing settlement. Observe shoulder settlement below the approach pavement and bridge abutment backwall header.

Approach Length Guidelines For Settlement

1) Length of approach slab plus pavement relief joint and sleeper slab, if present.
2) If no concrete approach slab is present or visible, use 50 feet from end of bridge deck.

Rating Examples

The numerical rating should reflect smoothness of the transition between approach pavement and bridge deck wearing surface. The emphasis is placed on vehicular impact to the bridge structure and safety of the vehicular traffic traveling at the posted speed limit. If an asphalt ramp is used to correct a settlement problem, its rating should reflect its effect on smoothness of transition. Do not rate the condition of the approach pavement as this is rated under Chapter 5.5.

7 - Indicates a smooth transition with no difference in elevation between approach pavement and deck and no pavement cracking.

5 - Indicates a minor difference in elevation just noticeable when driving over.

3 - Indicates a difference in elevation producing significant impact on the bridge. Approach slabs may not always be cracked in this situation due to subgrade settlement. The vehicles bounce noticeably.

1 - Indicates a major difference in elevation causing severe impact on the bridge and creating a major obstacle to vehicular traffic.
The newly constructed bridge and approaches are in excellent condition.

A transverse depression exists at the end of the asphalt overlaid concrete approach slab within both lanes. This causes minor rebound of vehicles onto the bridge, otherwise settlement would rate higher.
The approach has settled up to 2.5 inches with respect to the bridge joint. Vehicles bounce noticeably when crossing bridge.

The approach asphalt pavement is sloped toward the slab. A 3 to 4 inch swale-like depression occurs over 10 feet. This elevation change causes vehicular traffic to bounce on and off the bridge in a dangerous manner. Vehicles apparently familiar with this effect knowingly slow down.
5.4 - EROSION
(Approaches)

What To Rate

Rate erosion of embankment material from behind the abutment wingwalls and along the top of slope near the bridge caused by roadway runoff. Hatched areas in Figure 5.4.1 should be rated under this element.

What To Look For

Look for gullies forming behind the wingwalls and along the top of the embankment slope. The closer gullies and other material loss are to the roadway, the more critical they are. Look for original dirt lines on the back of wingwalls indicating loss of material. Look for exposure of guide rail post soil plates. Erosion from the front of abutments and wingwalls is rated under abutment and wingwall elements and not rated under this element.

Investigate sod and paved gutters along embankment slopes, which may erode severely, especially in gravel soils.
Approach Length Guidelines for Erosion

For U-Walls and Splayed Walls, approach length would extend 50 to 80 feet beyond the ends of wingwalls.

Rating Examples

7 - No loss of embankment material.

5 - Gullies or small voids occurring away from the roadway.

3 - Large voids or gullies close to the roadway.

1 - Large loss of material encroaching significantly upon the roadway.

Figure 5.4.2 – Rate 4
Erosion has exposed three guide rail posts’ soil plates. Some loss of soil has occurred inside the rail with minor encroachment into the shoulder.
Erosion has formed two gullies far outside the guide rail. One shallow gully is present along the wingwall. The other larger gully is present several feet from the wingwall.

The roadway drainage structure outlet pipe is disconnected. Consequently, erosion severely undermined the sidewalk while fully exposing several approach guide rail posts.
5.5 - PAVEMENT
(Approaches)

What To Rate

Rate the approach pavement and the joint between the abutment header and approach pavement (construction joint). If applicable, also include the sleeper slab and transverse pavement relief joint.

Figure 5.5.1 shows a joint rated under this element. It is a cross section of an abutment backwall.
What To Look For

Check for:
- Pavement riding quality – smoothness or roughness.
- Cracking, delamination, and spalling of concrete pavement.
- Cracking, rutting, raveling, potholes, and general disintegration of bituminous pavement.
- Wearing surface worn smooth; exposed polished aggregate can be slippery when wet in both concrete and bituminous pavement.
- Pavement joint water leakage as indicated by dampness and wetness of the abutment backwall.
- Deterioration of joint sealer or filler and joint riding quality.
- Loose pavement armor angles, if applicable. Broken anchors can be detected by tapping an angle with an inspection hammer.
- Deterioration of pavement relief joint, cracking, rutting, potholes, and uplift due to pavement shove.
- Wash boarding, rutting, potholes, and loss of crown of gravel roadway.
- Cracking and loss of individual bricks or cobblestones of brick roadway.
- Wearing of pavement grooving in wheel tracks may trap water and can lead to hydroplaning.
- Loss or wearing away of gravel roadway near bridge deck resulting in pavement dip and/or exposed vertical edge of deck.

Approach Length Guidelines For Pavement

1) Length of concrete approach slab plus transverse pavement relief joint and sleeper slab.
2) If no concrete approach slab is present or visible, use 50 feet from the end of the bridge deck.

Rating Examples

Consider the effect of material condition, riding quality, and safety.

Concrete Approach Pavement

7 - Indicates no cracks, delaminations, or spalls.

5 - Indicates beginning of a spalling problem with no more than two or three isolated, moderate spalls or delaminations. Pavement with only scattered tight cracks and moderate surface wear with good riding quality would also be rated 5.

3 - Indicates a more serious spalling and delamination problem with about 25 percent of one lane affected and poor riding quality. Pavement with no cracks or spalls but with a well-worn wearing surface of polished aggregate could also be rated 3.

1 - Indicates a spalling and delamination problem with about 50 percent or more of one lane affected. The ride would be extremely rough.
Bituminous Approach Pavement

7 - Indicates no cracks or rutting.

5 - A few minor tight longitudinal and/or transverse cracks with moderate surface wear and good riding quality.

3 - Some or all of the following: heavy alligator cracking, longitudinal pavement joint separation, rutting in wheel paths, potholes and/or serious raveling of the pavement surface. A pavement with poor riding quality would also be rated 3.

1 - Indicates pavement with extremely poor riding quality.

Gravel Approach Roadway

7 - Indicates a proper blend of well-graded gravel and soil that has proper crown for drainage and has a smooth ride.

5 - A few potholes, some surface wearing, and some grooving in wheel paths but still drains well and has a fairly smooth ride.

3 - Some or all of the following: many potholes, wash boarding, grooves in wheel paths, exposed vertical edge of deck due to loss of gravel paving, buildup of gravel along shoulders preventing proper drainage and/or poor drainage due to loss of crown. A pavement with poor riding quality would also be rated a 3.

1 - Indicates a pavement with extremely poor riding quality.

Brick or Cobblestone Pavement

7 - Indicates a non-skid, properly crowned surface.

5 - Minor brick cracking and displacement with some loss of grout with moderate surface wear but good riding quality.

3 - Some or all of the following: General vertical and horizontal displacement with some actual loss of individual bricks. Rutting in wheel paths and polishing of wearing surface. Loss of crown resulting in poor drainage. A pavement with poor riding quality caused by multiple patching would also be rated a 3.

1 - Indicates a pavement with extremely poor riding quality.
Figure 5.5.2 – Rate 4
The asphalt approach pavement is worn with numerous liquid asphalt sealed cracks. Several transverse and longitudinal cracks up to ¼” wide remain unsealed. Ride quality is unaffected.

Figure 5.5.3 – Rate 3
The concrete slab wheel paths are polished. The near lane is covered with tight random map cracks. Spalled areas are repaired with asphalt patch. The far lane has several longitudinal cracks. The asphalt pressure relief joint is cracked and broken with a rough ride.
Figure 5.5.4 – Rate 3
The concrete approach slab has localized, full-depth cracking adjacent to the joint header. Several soil filled voids have formed near the header, negatively affecting vehicle ride quality.

Figure 5.5.5 – Rate 2
The outside wheel track of the far lane is broken and potholed with uneven patches and a rough ride. These same conditions are found full length along the centerline of the roadway and full width in the near lane.
5.6 - GUIDE RAILING
(Approaches)

What To Rate
Rate the approach guide railing and approach median barrier, if applicable. Rate individual posts with no cable or railing, if such a system was part of the original design.

What To Look For
The primary function of any guiderail/barrier is to minimize loss of life. The objectives are: hazard elimination, vehicle retention, and vehicle redirection.

Look for ability of the approach guiderail and/or median barrier to function as originally designed. Do not rate adequacy of the railing type to meet current design standards.

Check for:
- Proper height per original design.
- Impact damage to rails and posts.
- Missing bolts at posts and splices.
- Excessive sagging or bending of rails.
- Post bent out of plumb.
- Any loss of post anchorage (i.e., erosion behind post soil plates).
- Continuity and connection of approach guiderail at transition to bridge rail, where applicable.
- Railing terminus anchorage.
- Cables raveling, loss of tension, continuity, and anchorage.
- Steel member corrosion and section loss.
- Concrete barrier impact damage, alignment, cracking, and salt attack.
- Wood member rot, insect attack, and splitting.
- Aluminum member cracks.
- Tears and ragged edges on metal rail extending outward toward oncoming traffic.
- Correct lapping of corrugated beam rail sections; blunt ends of rails should not be exposed to oncoming vehicles (i.e., lane nearest guiderail).
- Pockets along damaged rail that could capture a vehicle rather than redirecting it.
- Loose or missing masonry stones and failed mortar.
Approach Length Guidelines For Guide Railing

- For bridge approach guiderail installed solely to protect vehicles from striking the bridge components, consider the entire rail length to be the appropriate approach length.
- For bridge approach guiderail continuous with the highway guiderail, look for an obvious transition to use as the appropriate approach length.
- For bridge approach guiderail continuous with the highway guiderail but without obvious transition, use the approach slab length or a length of about 50 feet as the appropriate approach length.
- When different guiderail systems exist at the same approach end, each should be inspected based on these guidelines. It is thus possible to have more than one approach length, per approach, for guiderail.

Rating Examples

8 - For approaches with no guide railing and no evidence that it ever existed. This is also used when railing has been deliberately removed by the owner of the bridge because the railing was determined to be unnecessary.

7 - No deterioration or misalignment.

5 - Some minor deterioration of the posts and/or rails, but all components still in original position and functioning as originally designed.

3 - Major deterioration, impact damage, serious misalignment, significant looseness in the connections, resulting in weakening the railing well below original design.

1 - Severe impact damage or deterioration resulting in a totally ineffective system. This includes railings that are missing because of impact or deterioration.

Note: Approach railings that have an ineffective height because of multiple approach overlays should be downrated.
Figure 5.6.1 – Rate 5
There is one post bent with broken rail support clips. Minor erosion behind the adjacent post soil plate is present. No impact damage to “W” beam rail exists.

Figure 5.6.2 – Rate 3
Erosion has revealed several adjacent approach guide rail transition posts’ soil plates, thus reducing the containment capacity of the railing system. The box beams are intact and level.
Figure 5.6.3 – Rate 3
The approach concrete median barrier is severely spalled with exposed reinforcement at both faces. The exposed reinforcement does not protrude into the roadway.

Figure 5.6.4 – Rate 2
Sounding indicates the full length of the box beam approach rail is severely corroded. The worst section loss is located adjacent to the splice where holes have formed in the rail. The rail strength is reduced and unlikely to redirect or contain errant traffic.
CHAPTER 6
DECK

This chapter includes the following rating elements:

6.1 - WEARING SURFACE
6.2 - CURBS
6.3 - SIDEWALKS & FASCIAS
6.4 - RAILINGS & PARAPETS
6.5 - SCUPPERS
6.6 - GRATINGS
6.7 - MEDIAN

6.1 - WEARING SURFACE

What To Rate

This is either an overlay or the top surface of the deck that vehicles drive on. The wearing surface must provide an adequate driving surface. Concrete or asphalt wearing surfaces (whether overlays or integral surfaces) must also protect the structural deck and its rebars from the effects of traffic and weather.

Rate the condition of the separate overlay or the top surface of the structural deck. This does not include the approach pavements. The rating should consider riding quality, skid resistance and if the wearing surface is as watertight as designed.

Typical Wearing Surfaces

- Concrete wearing surface, including bonded overlay that is integral with concrete structural deck.
- Separate asphalt or concrete overlay wearing surface on concrete structural deck.
- Steel grating, open or filled.
- Timber, integral or separate planking.
- Asphalt concrete wearing surface on orthotropic steel decks or corrugated metal flooring.
- Gravel wearing surface used in fill configurations such as pipes or culverts.
**What To Look For**

When evaluating skid resistance, examine the condition of saw cutting or grooving and check for exposure of aggregate, glossy or shiny surface, etc. Look for areas of the wearing surface that pond water. This could be a serious deficiency if the wearing surface is not watertight.

For integral and concrete overlays, check for exposed polished aggregate, loss of grooving, scaling, spalls, cracking, wheel path ruts, and exposed rebars or mesh.

For asphalt concrete overlays, check for exposed polished aggregate, cracking, raveling, wheel path ruts, pot holes, washboard surface, and drying out of asphalt cement. Look for a lack of a good seal against the curb.

For patched spalls and potholes, check soundness of repair, vehicle ride quality, and water tightness.

For steel grating decks, check for profile misalignment and wear on the tops of the grating bars that reduce skid resistance. For filled steel grating, check for concrete wear or loss between grid bars. This exposes the grid to direct wheel contact that reduces skid resistance. "Cupping" of the concrete between the bars can hold water, further reducing skid resistance. Pack rust can cause some filled grating to warp and bow.

For timber, check for wear, rot, impact damage, insect attack, fire damage, splitting, inadequate fasteners and protruding fasteners. Where separate planking is used, whether full width, or in strips where wheels ride, listen for "slapping" under traffic.

For gravel, check for loss of crown, loss of stone, pot holes, wheel ruts, and washboard surface.

**Rating Examples**

**CONCRETE WEARING SURFACE**

7 - Indicates no cracks, delaminations, or spalls.

5 - Indicates beginning of a spalling problem with no more than two or three isolated, moderate spalls or delaminations. There may be only scattered tight cracks and moderate surface wear with good riding quality.

3 - Indicates a more serious spalling and delamination problem with about 25 percent of one lane affected and poor riding quality. A wearing surface with no cracks or spalls but with a well worn and polished aggregate.

1 - Indicates a spalling and delamination problem with about 50 percent or more of one lane affected. Extensive wide cracking is present. The ride would be extremely rough.
ASPHALT WEARING SURFACE

7 - Indicates no cracks or ruts.

5 - A few minor tight longitudinal and/or transverse cracks with moderate surface wear and good riding quality. Some minor raveling may be occurring at the curbs.

3 - Some or all of the following: heavy alligator cracking, ruts in wheel paths, potholes, and serious raveling of the wearing surface especially at the curbs. A wearing surface with poor riding.

1 - Indicates a pavement with extremely poor riding quality.

STEEL GRATING

7 - Indicates good alignment and skid resistance.

5 - Moderate surface wear but riding quality is still good.

3 - Some or all of the following: serrations worn smooth resulting in a slippery surface, heavily cupped concrete (for concrete filled grating), and vertical misalignment between grating sections.

1 - Indicates significant dips, depressions or other vertical misalignments resulting in an extremely poor riding quality.

TIMBER

7 - Indicates no cracks, splits or checks with only minor surface wear.

5 - Some wood deterioration, moderate surface wear but riding quality is still good.
   All hardware and connections are still intact.

3 - Some or all of the following: loose or missing planks, heavily worn surface, considerable wood deterioration. There may be loud noises with passing vehicles.

1 - Indicates extensive timber deterioration, many loose or missing planks and/or connections, protruding fastener tire puncture hazards, loud noises with passing traffic, with an extremely rough riding surface.
GRAVEL

7 - Indicates a proper blend of well-graded gravel and soil that has proper crown for drainage and has a smooth ride.

5 - A few potholes, some surface wearing, and some rutting in wheel paths but still drains well and has a fairly smooth ride.

3 - Some of the following: many potholes, wash boarding, ruts in wheel paths, loss of crown. A wearing surface with poor riding quality would also be rated a 3.

1 - Indicates an extremely poor riding quality. Deep ruts in the wheel paths, mud and/or the loss of gravel may be present.

Figure 6.1.1 – Rate 5
The newer steel grating deck shows minor wear to the teeth (serrations). The ends of several transverse bars are bent; possibly due to installation mishandling or snow plow impact.
The timber deck is splintered within the wheel tracks and at other locations. A gap has opened between the butt ends of the boards. One loose board end was removed by hand. The ride across the bridge is slightly bumpy, however the deck sounds solid and intact.

Figure 6.1.2 – Rate 4

The concrete wearing surface is polished in the wheel paths.

Figure 6.1.3 – Rate 4
The asphalt wearing surface has tight alligator cracking and several potholes, some with older patches. The riding quality is poor and the wearing surface is not watertight.

The bridge deck has a large patch comprised of asphalt and concrete sections. The concrete patch is mostly hollow sounding with some cracking. One location pumps water when vehicles pass over.
The original timber wearing surface was paved over. This asphalt wearing surface is now severely deteriorated, exposing the timber deck planks below. Heavy transverse and alligator cracking leak water to the elements below and make travel across the bridge rough and loud.

Figure 6.1.7 – Rate 1
Asphalt patches in the extensively spalled concrete wearing surface are loose and potholed. The concrete is loose and broken with wide, deep cracks and water ponding in the voids. The ride is extremely rough.
**6.2 - CURBS**

**What To Rate**

These are raised components on bridge decks that mark the edge of the roadway, redirect errant vehicles, and/or channel deck surface runoff to removal points. Include curb cutouts that are intended to drain the surface of the deck. The condition of approach curbs is included in the curb rating for the span nearest the approach. Inspect curbs on both sides of the bridge, but rate the condition for the side that is in the worst condition.

**EXCEPTIONS:** Curbs on medians are rated with medians. The "curb" area on safety shapes used as bridge railing is rated with parapets.

**Typical Curbs**

- Cut stones such as granite, backed up by a concrete sidewalk.
- Steel curbs attached to steel sidewalks or structural members that may also be backed up by concrete sidewalk.
- Concrete curbs may be precast and set similarly to granite, or integral with a cast-in-place concrete sidewalk or parapet.
- Timber curbs can be single timbers or built-up members, generally attached to the deck. Such curbs do not usually have a backup sidewalk.

**What To Look For**

Check alignment and end treatments, and be aware that successive deck overlays may reduce the effectiveness of the curb. Blunt ends and misalignments may cause problems for snowplows and errant vehicles. Dirt and debris along the curbside reduce the curb's visibility and effectiveness, and cause drainage water to extend onto the wearing surface.

If curbs have slots or openings allowing drainage water to pass through, they must be checked.

**Cut Stone:** Check for loose or broken sections and integrity of the mortar joints or seals at the top, bottom, and between sections.

**Steel:** For concrete-backed curbs, check the seal at the top between the curb and the sidewalk. For steel curbs that do not have a concrete backing, check for loose sections and corrosion of connections to the steel support system. Check the welds between individual plates if used, and check the seal at the gutter line. For curbs welded to sidewalks, brackets, or structural steel members, check welds carefully. Cracks in these welds may propagate into structural steel members.

**Concrete:** Check for spalls, cracks, scaling and exposed rebars. Keep in mind that sharp edges or exposed rebars may be a hazard to oncoming traffic. With precast sections, check as for cut stone. Any steel facing or scrub strips protruding from proper alignment should be considered a serious deficiency.
Timber: Check for splitting, rot, insect attack and anchorage. Sometimes, the curb is mounted on blocks to provide drainage; make sure these openings are clear of debris.

Rating Examples

7 - Curbs are in new or like-new condition.

5 - Curb reveal has been reduced by than less than 20% due to debris, has minor scaling, some mortar missing in joints, or other minor surface defect.

3 - Original curb reveal has been reduced to 50% or less due to debris or wearing surface overlays (becomes mountable), is heavily spalled with exposed rebars which do not present a tire puncture hazard, or lacks seal at the wearing surface.

1- Curb does not redirect traffic and/or channel drainage, is extensively deteriorated, has loose or missing sections, or has exposed rebars or facing strips hazardous to vehicle tires. May be level with the pavement (no reveal) and be ineffective.

Rate curbs 8 if there are no curbs present. Sometimes, curbs may be paved over intentionally and should be rated 8, with explanatory comments.

Figure 6.2.1 – Rate 7
The bridge, including the steel curb, was recently painted. Previously rated 6 for minor surface rust, the curb is now rated 7 to reflect the like new condition.
There are some minor checks and splits, but otherwise, the timber curb is sound and the connections are good. The drainage cutouts are clear of debris.

The bridge curb is damaged and the steel facing is partially missing. The end of the broken steel curb facing extends 1 inch into the approach shoulder. The approach curb has settled.
Figure 6.2.4 – Rate 3
The curb is in good condition, but subsequent pavement overlays have reduced the curb reveal from 6” to 3”.

Figure 6.2.5 – Rate 1
The curb is heavily deteriorated. Exposed reinforcement presents a tire puncture hazard.
6.3 - SIDEWALKS & FASCIAS

What To Rate

Rate the sidewalk for its ability to provide a safe walking area, and the fascia for ability to support attachments. Inspect sidewalks and fascias on both sides of the bridge, but rate the condition of the element that is in the worst condition. Rate the worst side of the sidewalk or fascia. If both sidewalks and fascias are rated 4 or less, provide comments on both. The condition of approach sidewalks is included in the sidewalk rating for the span nearest the approach.

EXCEPTIONS: The condition of the sidewalk support members is included in the rating for primary members. Some structures do not have ratable fascias, such as through-girders, trusses, pipes and box culverts. The ends of wooden decks are not rated as fascias.

Typical Sidewalks and Fascias

SIDEWALKS:
- Concrete overlay placed on top of the structural deck, generally together with the fascia and curb.
- Structural concrete generally placed outside the deck. Sometimes partly supported by the deck (curb area) and sometimes separate from the deck (through girders and trusses).
- Steel, such as diamond plate or grating, used either as safety walks or full sidewalks.
- Timber
- Asphalt overlay on concrete or timber walks.

FASCIAS:
- Concrete
- Occasional use of steel.

What To Look For

Check fascia concrete for cracks, scaling and spalls. Be aware that on bridges spanning roadways, pedestrian areas, navigable waterways, or railroads, fascias must be checked carefully for signs of material that has fallen or is likely to fall and cause accidents or injuries. Check all attachments such as rail posts, light standards and signs. Look for loose or missing anchor bolts, and for cracks and spalls in concrete that may admit moisture to anchorage systems. Check also for loss of concrete that reduces anchorage effectiveness. Rate only the condition of the concrete and its ability to secure the anchorage system.

Sidewalks should be checked for the quality of the walking surface. Look for deterioration, tripping hazards, accumulation of debris, or ponding water.

Concrete: Check for cracking, scaling, spalling and misalignment at joints. Consider patches of dissimilar material temporary and note them in the report. Check the underside of structural sidewalks for soundness, dampness, cracking, spalls and efflorescence.
Steel: Check welds and connections. If cracks are detected, make sure they do not propagate into structural steel members. Occasionally, steel plates are used as a fascia with attached posts for the bridge railing. If the posts are welded to the primary members, the welds may require 100% hands-on inspection (see also Appendix C).

Timber: Check for splitting, checking, rot, insect attack and anchorages.

Rating Examples

SIDEWALKS

7 - All sidewalks are in new or like-new condition.

5 - Walking surface is intact. The sidewalk may have permanent patches of similar material with perhaps some minor scaling.

3 - Large areas are deteriorated with shallow spalls. There may be temporary patches. The underside of structural sidewalks would be heavily cracked, possibly with spalls, dampness and efflorescence.

1 - Surface is unsafe for walking. The material is extensively deteriorated with large areas of spalling and delamination on the underside.

FASCIAS

7 - Both fascias are in new or like-new condition.

5 - Minor cracking and perhaps some spalling at joints, but should sound solid when struck with a hammer. Anchorages are good.

3 - Heavy cracking with efflorescence, large spalls with exposed rebars. Attachment anchorages may be partly exposed.

1 - Inadequate support for rail posts, signs, parapets, etc.
Figure 6.3.1 – Rate 6
The steel fascia with attached rail posts is only lightly rusted with no section loss. Check the special emphasis section of the inspection binder for locations of critical details.

Figure 6.3.2 – Rate 5
Minor scaling of the concrete sidewalk surface is visible. Tight transverse cracks emanate parallel to the thru-girder’s stiffeners.
Figure 6.3.3 – Rate 3
The sidewalk has scattered shallow spalling. Some areas are patched, but these areas sound hollow when struck.

Figure 6.3.4 – Rate 3
The concrete fascia is severely spalled with exposed rebars and loose concrete. The rail posts anchorages are still solid, therefore a rating lower than 3 is unwarranted.
Figure 6.3.5 – Rate 1
The fascia is severely spalled up to 6 inches deep with exposed reinforcement. All post anchorages have lost adequate embedment and the bridge rail can be easily moved by hand.

Figure 6.3.6 – Rate 1
The underside of the sidewalk is extensively deteriorated and spalled with exposed, rusted reinforcement. The top of the sidewalk is severely spalled and is closed to the public. One punch through is now covered with a steel plate and topped with asphalt.
6.4 - RAILINGS & PARAPETS

What To Rate

Inspect the railing and/or parapet attached to both sides of the bridge superstructure or deck. Rate the worst side. If there are both railings and parapets, rate the lower of the two elements. If both elements are rated 4 or lower, comment on both. Include the rails, posts and anchorages. Some bridges have separate railings for vehicles and pedestrians. If this is the case, rate the worst of the two types of railing or parapet. Include the condition of fencing if used. For bridges with newer independently supported railing or parapet systems placed traffic side of existing abandoned systems, rate the condition of the new system and comment on both as necessary.

The primary function of any railing/barrier is to minimize loss of life. The objectives are to provide some level of hazard elimination, vehicle retention, and vehicle redirection.

Rate the ability of the bridge railing and/or parapet to function as originally designed. Do not rate adequacy of the railing type to meet current design standards.

LIMITS OF INSPECTION: If there is a transition section between the bridge and approach railing, then rate the bridge railing up to this point. For bridge railing carried across the abutment and supported on U-type wingwalls, this transition can occur at the approach, well beyond the abutment backwall. Rate the portion of the bridge rail attached to the U-type wingwall with the bridge railing for the adjoining span.

Typical Railings and Parapets

**Metals:** Usually steel or aluminum supported on posts or attached to primary members. They can be fabricated shapes, pipe, W-sections, box-beam, spindles and many other manufactured types. Steel members may be painted, galvanized or bare weathering steel. Cable railings are sometimes used for pipes or culverts with fill.

**Concrete:** Usually in the form of parapets with or without a metal rail on top, various cast-in-place shapes, and safety shapes (Jersey barriers).

**Masonry:** Laid up stone or brick. Some masonry walls may actually be a veneer on a concrete core.

**Timber:** Common on local bridges

What To Look For

Check vertical and horizontal alignment, continuity (if applicable), deterioration, impact damage, rail-to-post support, anchorage systems, and broken or missing rails or posts. Note that misaligned railing can be indicative of a serious deficiency in the superstructure or substructure of the bridge.
Metals: Check for cracks, broken components, cracked welds and missing or loose bolts. Look for section loss (especially at the bottom of the posts), bent rails, broken hangers, missing nuts and missing or rusted anchor bolts. Consider the condition of the fascia and its effect on anchorage. Consider the condition of paint or galvanizing when rating the railing. For unpainted weathering steel, consider how effective the oxide film is in protecting the steel from further corrosion. Note that weathering steel has a tendency to corrode from the inside of the rail to out. Therefore, a rail that looks good must be sounded to detect defects.

Concrete: Check for spalling, cracks and anchorage for rails that may be attached on the top or sides. Look for evidence of spalling on the outside of the railing or parapet similar to fascias that may fall onto highway traffic or pedestrians below. For safety shapes, rate the "curb" area with the parapet. Check for tipping. This may indicate poor anchorage.

Masonry: Check for loose or missing stones and failed mortar joints. If supplemented with another rail system, also check anchorages.

Timber: Check for splits, checks, rot, insect damage, and connections.

Rating Examples

7 - New or like-new condition.

5 - Minor concrete spalls, mortar loss in stone work, minor section loss or bent members, or a few non-critical fence ties missing.

3 - Concrete spalled with rebars exposed, stones loose or missing, bolts missing, small parts on rails or fence missing, measurable section loss, or impact damage hindering full function of the rail or parapet. Concrete parapets and rails tipped from vertical.

1 - Broken or missing sections of rail or parapet so that it is totally ineffective.

Figure 6.4.1 – Rate 7

Shown is a new independently supported railing system placed traffic side of existing abandoned railing. The condition of the new railing system controls the rating.
Figure 6.4.2 – Rate 6
The masonry parapet is in very good condition. There is only a very minor amount of mortar deterioration.

Figure 6.4.3 – Rate 5
Shown is a wooden pedestrian railing with a somewhat uneven top surface and some minor splitting of the posts. The hardware is all intact.
The steel "W" railing has 100% paint failure with some section loss. The anchor bolts are significantly corroded, reducing the reserve capacity of the system.

The railing was impacted, shearing the post at the base. Also, a rail section and end vertical are missing.
6.5 - SCUPPERS

These are openings in the bridge deck for bridge drainage.

What To Rate

Rate the effectiveness in removing water and small debris from the deck, and in directing flow away from bridge components. Include the condition of all discharge piping that may be attached to the scuppers.

EXCEPTIONS: Plumbing systems associated with joint or trough drains at abutments or piers are rated with joints. Some decks with a separate wearing surface have small deck drains with weep pipes resembling scupper pipes. Do not rate these as scuppers, but as part of the deck. Horizontal deck drains (curb cutouts) that outlet at the fascia are rated with curbs.

Typical Scuppers

- Round or square pipe that simply allows drainage to pass through the deck. It may have a bar across the top.
- Cast in the deck with bars or grates in the opening. These scuppers are usually cast or fabricated metal boxes.
- Drop-inlet frame and grate cast in the deck with a pipe outlet box attached

What To Look For

Check to see that all scuppers and grates used as scuppers are securely attached to the deck. Check for openings free of debris and dirt, allowing deck runoff water to flow. Check the seal between the inlet and surrounding deck. Deterioration around the inlet allows runoff water to penetrate the deck concrete. All piping associated with the system must be checked for broken or missing hangers, loose joints, separated connections, and split or missing pipes. Any short scupper pipes that do not discharge away from structural members should be rated low. Also, look at the discharge point for signs of causing erosion at a substructure or the embankment.
Rating Examples

7 - A new or like-new system.

5 - Some minor restriction at the inlet or minor deficiencies in the plumbing, but the system still functions as designed.

3 - Serious problems such as one totally plugged inlet, a burst or disconnected pipe, discharge point not releasing water, broken concrete or seal at the inlet, broken or missing hanger, or misdirected outlet causing embankment erosion or damage to structural members.

1 - Indicates an extreme level of ineffectiveness. This could be all scuppers plugged, one or more plugged scuppers causing water to pond on the deck, broken gratings or bars exposed to traffic, or broken grating support bars. One or more misdirected or broken outlets are causing significant embankment erosion or significant damage to structural members.

If scuppers are intentionally plugged as part of a rehabilitation that provides for other means of deck drainage, rate scuppers 8.

Figure 6.5.1 – Rate 4
The scupper inlet is restricted by debris but still functions.
Figure 6.5.2 – Rate 3
The scupper outlet pipe is broken which allows water to fall on the primary member. Consider lower rating if water contributes to corrosion of superstructure or erosion below.

Figure 6.5.3 – Rate 1
All scuppers are totally plugged which allows standing water on the deck.
6.6 - GRATINGS

What To Rate

These are large open drainage devices in the deck. They may extend the full length or nearly the full length of the span or may be intermittent. Gratings are designed to support wheel loads. They collect and remove water from the deck and are generally installed in the shoulder area adjoining the curb.

Gratings are open on the underside and are supported by steel bridge members. Rate gratings for ability to drain deck runoff, support wheel loads, and ride smoothly.

EXCEPTIONS: Structural members that support the gratings are rated as primary members. Individual gratings used with drop inlets as scuppers are rated as scuppers. Rate 8 for retrofitted gratings filled with concrete; filled gratings should be rated under the Wearing Surface (Chapter 6.1) and Structural Deck (Chapter 7.1) elements.

What To Look For

Check that openings and grates are free of debris and dirt and allow deck runoff to enter. Check the seal between the grate frame and the surrounding deck. A poor seal allows water to penetrate the deck concrete. Check for corroded, broken, cracked or missing parts. Check all support connections, and in particular, look for cracks in welds. See also Chapter 7 for additional information and rating guidelines regarding grating decks.

Water and debris discharge onto structural bridge components is not considered in rating gratings because gratings are not designed to protect structural bridge members. Any deterioration to individual bridge components caused by leakage from gratings should be reflected in the ratings for their respective elements as appropriate.

Rating Examples

7 - New or near-new condition.

5 - Minor deterioration such as two or three broken bearing bars.

3 - Significant section loss or 10 percent or more broken bearing bars.

1 - Extreme deterioration or large number of broken bearing bars possibly exposed to traffic. The grating’s ability to support wheel loads may be in doubt.
The intermittent grates are moderately rusting, but without any appreciable section loss. The seal between the grate frame and the adjoining deck is good.

Many of the grating’s steel sub-support bars are severely deteriorated. It is questionable if wheel load can be adequately supported. Rating depends on severity of deterioration.
6.7 - MEDIAN

What To Rate

Rate the median’s ability to separate opposing traffic on multi-lane bridges. Include the condition of curbs and traffic barriers if any are present.

EXCEPTIONS: Flush medians without a traffic barrier, consisting solely of paint or reflective pavement markings are not rated as medians. Their condition is included in the rating for wearing surface. Lighting, signs or utilities located on medians are rated under their respective rating elements.

Typical Medians

- Flush median with a traffic barrier such as guiderail, box beam or safety shape.
- Raised median, either mountable or non-mountable. May have a traffic barrier.
- Flush median with stone-chip surface or open grating. No barrier.

What To Look For

If the median is raised concrete, inspect as for concrete sidewalk and curb. Check all rail systems for alignment, impact damage, missing hardware, and post anchorage. For safety shapes, check alignment, misplaced sections due to impact, and concrete deterioration. If present, check the condition of the drainage slots. For all types of medians, check the longitudinal joint, if present, for the quality of seal. Inspect as for transverse joint, but rate with median.

For flush medians with open steel grating, inspect the same as deck drainage gratings.

Deficiencies in median material that affect the support for lighting standards, sign or utility supports should be considered in the rating for medians.

Rate the poorest component of the median. Add a remark in the inspection report indicating which component is being rated.

Rating Examples

For additional rating example guidance see chapters:

4C.2 - JOINTS
6.2 - CURBS
6.3 - SIDEWALKS & FASCIAS
6.4 - RAILINGS & PARAPETS
6.6 - GRATINGS
Sections of longitudinal compression joint material are missing or loose. These conditions cause water leakage and surface corrosion to the members below.

The raised median guiderail was damaged by impact. One post is missing and one post is bent, thus reducing its design capacity.
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This chapter includes the following rating elements:

7.1 - STRUCTURAL DECK
   7.1A – REINFORCED CONCRETE
   7.1B – TIMBER
   7.1C – GRATING

7.2 - PRIMARY MEMBERS
   7.2A – REINFORCED CONCRETE
   7.2B – PRESTRESSED CONCRETE
   7.2C – STEEL MULT-GIRDER
   7.2D – TWO AND THREE-GIRDER
   7.2E – METAL TRUSSES
   7.2F – TIMBER
   7.2G – STONE MASONRY ARCHES
   7.2H – OTHER BRIDGE TYPES

7.3 – SECONDARY MEMBERS

7.4 – SUPERSTRUCTURE PAINT
   7.4A – NON-WEATHERING STEEL
   7.4B – WEATHERING STEEL

7.5 – SUPERSTRUCTURE JOINTS

7.6 – SUPERSTRUCTURE RECOMMENDATION
7.1 - STRUCTURAL DECK

What To Rate

The structural deck is the member or members transmitting loads from the wearing surface to the primary members. Sleepers and crossbeams are also included in the rating for Structural Deck.

EXCEPTIONS: Where all loads are carried directly by the primary members (such as adjacent box girders, slabs, frames, box culverts, and filled arches) there is no structural deck and the element should be coded 8. Additionally, integral and separate wearing courses such as concrete overlays with temperature control reinforcement are considered and rated as wearing surfaces. Rate flanges of precast T-beams and precast NEXT D beams or tops of precast box beams under the primary member element and code the structural deck element as 8. For decks without a separate wearing course, rate surface characteristics such as riding quality and skid resistance under the wearing surface element.

Typical Decks

Common types of structural decks are:

- Reinforced concrete with separate wearing surface
- Reinforced concrete with integral wearing surface
- Jack Arch

(Note: For the above common structural deck types, S.I.P. forms or flanges of NEXT F beams may be used as structural deck construction aids. Deterioration of these construction aids may not directly reflect the condition of the underlying structural deck. Therefore, their condition should not be used as the sole basis of the structural deck assessment and rating.)

- Timber planks, nail-laminated timber, glue-laminated timber, stress-laminated timber
- Open and filled steel grating

Other types include:

- Precast concrete planks
- Metal orthotropic
- Asphalt filled metal S.I.P. forms (Note: S.I.P. forms are the structural deck and should be rated accordingly)
- Structural steel plates

Rate the three most common deck types as follows:
**7.1A – REINFORCED CONCRETE**

The rating is generally determined by inspecting the bottom of the deck, including the haunches and soffit. If the top of the structural deck can be seen (not the top of a separate wearing surface), the assessment will be more accurate. When rating concrete decks, remember that concrete deterioration normally starts at the top of the deck and along its periphery. From these locations, deterioration progresses downward and inward until the entire deck is involved. Thus, when minor deterioration is observed on the bottom of a deck, deterioration is probably much worse within the deck.

**What To Look For**

Look for signs and extent of leakage through the deck (rust stains on girders, dampness, map-cracking and efflorescence). Look for cracks, spalls, delaminated areas (by soundings), rust stains on S.I.P. forms, and check the condition of haunches (see Appendix C for haunch special emphasis guidance), if present. Dampness on the deck underside may sometimes be caused by condensation from a cold deck or a stream below. Do not confuse this with leakage through the deck.

Review documentation of any core results (in the BIN folder) and inspect any open core holes.

Where there is a separate wearing surface, water will often accumulate between the wearing surface and deck. Check for increased signs of leakage where the water should drain such as along curb lines or near joints at the low end of the span.

The inspection should include both a general view of the deck for the entire span and a close view with sounding where appropriate. The general view will show the extent of deterioration. Areas where heavy leakage and spalling have occurred, or concrete appears saturated, should be sounded with a masonry hammer and findings documented. Temporary removal of planking or netting installed to catch falling concrete may be necessary for access to inspect the deck.
Areas of map cracking, wetness, efflorescence, and spalls should be expressed in percentages of the deck area. For decks rated 4 or lower, sketch the deck underside showing the extent of these deficiencies. Condition comments may be provided in lieu of a deck sketch when:

- conditions are uniform throughout the bridge deck.
- isolated conditions and their locations are accurately described in the condition comments.

In such cases, condition comments should indicate why the deck sketch was not provided.

Pay special attention to areas such as haunches or soffits where fragments may fall on vehicle or pedestrian traffic below.

**Rating Examples**

7 - Deck is new or near new, almost no sign of deterioration.

5 - Only localized areas of leakage (e.g., single longitudinal crack with leakage, or deck edges showing only spotty leakage. From the top, cracks are open and obviously allow infiltration of water and chlorides but with minimal signs of rebar corrosion or deck deterioration).

3 - 75 percent or more of the deck has leakage. Only localized spalled areas and remaining concrete is sound. Efflorescence along the girder top flanges.

1 - Heavy spalling. Heavy efflorescence. Punch through has occurred or is likely. Deck saturated to point that concrete is rubble.

![Figure 7.1A.2 – Rate 5](image)
The concrete deck exhibits localized transverse cracks. Efflorescence along the cracks indicates leakage. One delaminated area was recently removed and patched.
Figure 7.1A.3 – Rate 3 or 4
The jack-arch corrugated forms are corroded. This alone does not constitute downrating as moisture from below could cause this. However, efflorescence along the bottom flange concrete encasement provides evidence of significant deck leakage.

Figure 7.1A.4 – Rate 3
Efflorescence is present along the top flanges and at cracks located throughout the entire deck. There are no spalls.
Heavy deterioration of the precast panels' exists with deep localized spalls exposing reinforcement and prestressing strands. Punch through is a concern, otherwise the structural deck would rate 3. (Note that the fascia element would also rate low.)

The reinforced concrete deck exhibits locally severe deterioration with deep spalling, exposed debonded reinforcement and the possibility of punch through. The remainder of the deck is moderately cracked, spalled and/or leaking.
7.1B – TIMBER

What To Look For

Look for loose individual planks or boards, dampness, decay, splitting, loss of material through wear, checking (longitudinal cracks due to drying of timber), and separation of glue or nail laminations. Look for wood crushing at bearing locations. A 10 percent loss of material due to rot will reduce section modulus, thus lower the bending capacity by 20 to 30 percent or more. If a single plank is in poor condition, judge whether adjacent planks will carry the traffic loads safely. Listen for thumping and banging while looking for excessive deflection under live load.

EXCEPTIONS: Many bridges have longitudinal planks running over transverse timber decking. Running planks should not be rated with the deck but are rated as wearing surface.

INSPECTION INTENSITY: A timber deck can generally be inspected from both top and bottom. Visual inspection of the overall deck will give a good indication of the rating. Areas of dampness and random dry areas should be checked for soundness using a hammer, awl, knife, or drill with a small bit.
Rating Examples

7 - Deck is new or near new, almost no sign of deterioration.

5 - Capacity is not affected, but there may be:
   - Less than 5 percent of area with partially deteriorated planks.
   - Minor checking caused by drying timber.
   - A few warped individual planks.

3 - Timber is decayed or otherwise deteriorated in more than 20 percent of area.
   Broken planks affecting structural capacity.
   Delaminations of glue or nail laminated decks.

1 - Deck appears to be unsafe for posted or legal loads.
   Significant holes in decks.
   Extensive rotting of deck members.

Figure 7.1B.2 – Rate 4
The timber deck is wet with random localized soft areas over the girders. The planks are displaced 1/4 in. down at the splices. Most deck clips exhibit 100% corrosion loss.
Several timber planks are loose or are checked and deteriorated to the point of leaving gaps.

The underside of the timber deck is severely stained with widespread rot. Awl penetration is 30 percent.
7.1C – GRATING

What To Look For

Grating (grids) can break, or become loose, or missing due to wear, section loss, and/or impact loading. Primary bar wear and section loss caused by corrosion often occurs directly over the supporting floor system. Impact loadings by snowplows blades, etc., cause gouges, bends, and tears.

When inspecting welded or riveted open steel grating, look for broken welds especially between bases of primary bars and top flanges of the supporting floor system. Grating with many broken welds can shift under passage of traffic. Listen to the response to traffic loads to determine if the grating is loose. Rivets connecting bars can shear or drop out.

When inspecting filled grating, look for spalling/abrasion of the concrete filler. Look for bar distortion caused by corrosion.

Include the condition of sleepers transversely spanning the primary members with the deck rating. Check extent of section loss on these members. Accumulation of sand and salt on sleeper flanges often accelerates deterioration of these members.
Rating Examples

7 - Deck is new or like-new; no broken welds, loose components, or mechanical wear.

5 - Minor localized mechanical wear, isolated broken welds, no loose components, no grating bar section loss. Sleepers may have minor section loss.

3 - Bars have significant section loss, many broken welds, loose and noisy grating under traffic. There may be a few missing bars. Sleepers may be corroded to the point that ability to carry design loads is questionable.

1 - Large areas of missing bars, permanent loss of profile due to section loss from mechanical wear and/or corrosion.

Figure 7.1C.2 – Rate 5
Adjacent the deck joint, the concrete filled steel grating has one area of broken and deformed bars. Within this area the concrete has fallen thru, the grating is slightly bowed and banging can be heard with the passage of live load. The remainder of the deck appears in good condition with minor section loss to the sleepers.
Figure 7.1C.3 – Rate 3
The transverse sleepers are in poor condition with isolated areas of heavy corrosion and rusted thru holes in the web. The connection welds between the girders, sleepers and steel grating are broken at various locations. Banging can be heard under live loading.

Figure 7.1C.4 – Rate 2
The steel grating deck has main bars parallel with the stringers. There are no transverse sleepers and a permanent 2 inch deformation is evident in the wheel paths.
7.2 – PRIMARY MEMBERS

These are structural members that are designed to resist applied dead load and/or live load forces. They are the main members of the bridge that transmit loads generally from the deck to the bearings. Some components of a bridge do not precisely fit this definition but are nonetheless rated as primary members. They are explained further later in this chapter.

What To Rate

Rate the physical condition and functional capability of the primary members and connections (including fasteners) between primary members. Primary members must be rated as a system on a span-by-span basis. For example, on a girder-floorbeam-stringer span, consider all three components and their connections.

Typical Primary Members

- Reinforced concrete I beams, T beams, slabs
- Prestressed concrete box beams, I beams, NEXT beams, slabs, hollow slabs
- Steel multi-girder
- Two & Three Girder (with or without floor beams and stringers)
- Steel box-beam
- Steel or timber trusses
- Timber slab or stringer
- FRP Slabs
- True arch
- Spandrel arch, open and filled
- Concrete rigid frame
- Diaphragms attached to curved girders
- Grating support members
- Sidewalk support members
- Other bridge types (see figure 7.2.1)
<table>
<thead>
<tr>
<th>Bridge Type</th>
<th>Primary Member</th>
<th>Secondary Member</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Girder</td>
<td>Girders</td>
<td>Intermediate diaphragms</td>
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<td>Welded girder/diaphragm connections</td>
<td>Lateral bracing</td>
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<td></td>
<td>Web stiffeners</td>
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<td></td>
<td>End diaphragms that support the deck</td>
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<tr>
<td>Curved</td>
<td>Girders</td>
<td>Lateral bracing</td>
</tr>
<tr>
<td>Multi-Girder</td>
<td>Welded girders/diaphragm connections</td>
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<td>Diaphragms</td>
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<tr>
<td>Two &amp; Three</td>
<td>Girders</td>
<td>Knee Braces</td>
</tr>
<tr>
<td>Girder</td>
<td>Floor beams</td>
<td>Diaphragms</td>
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<tr>
<td></td>
<td>Stringers</td>
<td>Lateral bracing</td>
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<tr>
<td></td>
<td>Stringer/Floorbeam Connections</td>
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<tr>
<td></td>
<td>Floorbeam/Girder Connections</td>
<td></td>
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<tr>
<td></td>
<td>Web stiffeners</td>
<td></td>
</tr>
<tr>
<td>Truss</td>
<td>Truss members and connections</td>
<td>Portal Bracing</td>
</tr>
<tr>
<td></td>
<td>Floor beams</td>
<td>Lacing Bars</td>
</tr>
<tr>
<td></td>
<td>Truss/Floorbeam connections</td>
<td>Batten Plates</td>
</tr>
<tr>
<td></td>
<td>Stringers</td>
<td>Stay (Tie) Plates</td>
</tr>
<tr>
<td></td>
<td>Stringer/Floorbeam connections</td>
<td>Top &amp; Bottom Lateral</td>
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<tr>
<td></td>
<td>Gusset plates</td>
<td>Bracing</td>
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</table>

**BRIDGE MEMBERS**

**Table 7.2-1**
PRIMARY MEMBERS IN DIFFERENT TYPES OF BRIDGES
Figure 7.2.1
What To Look For

All primary members should be examined for signs of overstressing, fire damage, impact damage, improper profile or alignment, deterioration, or excessive movements with passage of live loads.

Behavior of primary members can best be observed during the passage of heavy live loads. Look for the cause of any unusual sounds or excessive movements with the passage of live loads. If it involves a deficiency in the primary members, it should be considered in the rating.

Rating Examples

7 - The primary member system shows no evidence of deterioration, performing at full-design capacity.

5 - The primary member system exhibits isolated areas of minor types of deterioration/damage without significant effect on the system's ability to perform at the full original design capacity.

3 - The primary member system has extensive, serious material deterioration or can no longer achieve its full original design capacity. However, the system is still able to react elastically to loadings but perhaps at a reduced capacity.

1 - The primary member system is ineffective in sustaining the original design loadings due to deterioration and/or damage and may not be capable of safely supporting even minimum live loads.

Rating Considerations

The inspection rating is closely tied to the primary member deterioration or damage and also how well the primary member system retains its original design structural capacity.

Primary member rating is based on the performance of the primary member system as a whole for the span being rated. An individual primary member may be in poor condition because it has impact damage or is significantly deteriorated. The primary member rating for that span may be higher if the deteriorated member is not critical for the performance of the span as a whole, i.e., the entire span continues to function elastically.

A low rating for primary members is justified where a deficiency for even one component is so critical as to significantly reduce the bridge load capacity.

Downrate primary members only for distress exhibited in the primary member system. Do not downrate if a span's structural effectiveness is reduced by deterioration or failure of another bridge element, such as frozen roller bearings, spalled pedestals, or even failed substructure columns unless the problem directly affects the primary members.

Except in very rare cases, a rating of 9 (unknown) must not be used for primary members. If a metal primary member is partially or completely encased in concrete, it should still be rated other than 9. In these cases, condition of the encasement and any exposed areas will be the basis for the rating.
describe condition of encasements and partially exposed primary members. Lower flange corrosion will result in deterioration of concrete encasements. Notify the RSME and request further investigation if serious deterioration appears to affect load capacity.

A legitimate use of 9 for primary members is for a totally enclosed span with no means of access. One example is an end span of a bridge with a solid pier and full-height curtain walls that totally enclose the span. The bridge owner should be notified about the need to provide a means of access. The 9 rating is expected to be a temporary one until access is provided. If access cannot be provided, or poses too great a hazard to inspectors, the 9 ratings will be allowed to stand. Written permission from the Deputy Chief Engineer (Structures) must be obtained for continued use of 9 ratings for primary members.
7.2A – REINFORCED CONCRETE

What To Rate

The physical condition and functional capability of the primary members are rated under this element. For filled arches, spandrel walls should be included in the primary member rating even though they do not directly carry live load. Loss of a spandrel wall would result in loss of the fill and failure of the bridge.

Typical Reinforced Concrete Primary Members

The following concrete elements are considered Primary Members:
- Rigid frames (Cast-in-place and precast)
- Filled arches Type 1 (no stems) and Type 2 (with stems)
- Arch ribs, spandrel columns, and spandrel walls
- Cast-in-place slabs
- Precast reinforced concrete slabs
- Cast-in-place through girders
- T-Beams (stem portion if cast-in-place, entire unit if precast)
- Channel Beams

What To Look For

Generally, alignment and profile of concrete elements should be examined for damage due to impact, overstressing, or substructure movement. Note any excessive vibrations or movement with passage of live loads. The inspection should determine the cause of any unusual sounds, excessive movement, or vibrations with passage of heavy loads.

The inspection should cover the following:
- Deterioration at the end of the beam which can lead to loss of bearing area and local crushing of the remaining concrete, especially when there are low skews and short end of beam overhangs.
- Near bearing areas at the ends of slabs, girders, T-beams, channel beams, etc., for spalling and cracked concrete. Any diagonal cracking in spandrel columns or at the ends of beams, girders, etc., is serious.
- Areas near supports for diagonal (shear) cracks occurring on exposed vertical surfaces and projecting diagonally toward the top of the girder, beam, etc.
- Tension areas at midspan of simple spans for flexural cracks extending transversely across the underside of the primary member. Longitudinal flexural cracks in the deck when the primary rebars are transverse. Transverse flexural cracks in tops of beams (slab portions) at or near piers on continuous spans.
- Areas with efflorescence indicating contaminated concrete and with rust stains indicating rebar corrosion. Spalling, delaminations, and pop-outs commonly associated with deterioration. In severe cases, rebars will be exposed; determine the section loss of any exposed rebars.
- Longitudinal cracks between adjacent channel or T-beams indicating possible broken shear keys, differential deflections under passage of live loads, leakage, etc.
Shear or torsional cracks at open spandrel arch floor systems, bent cap interfaces, or in spandrel bent caps or columns. Cracks in tension areas of spandrel bent caps (i.e., midspan at the bottom and ends at the tops).

Deterioration of closed spandrel arches and spandrel walls to include cracks, discoloration, spalling, exposed rebars, etc. Differential movement, change of alignment/profile or loss of fill.

Shear cracks in rigid frame beams (beginning at the frame legs and propagating toward the adjacent span), in the frame legs (beginning at the top and propagating downward), and in the ends of frame beams at end spans.

Flexural cracks in tension areas of rigid frames at the bottom of the frame beam at midspan, inside faces of frame legs at mid-height, the base of each frame leg, and the outside corners of a simple-span slab frame.

Areas at, near, or under drainage features such as scuppers, weeps, curb lines, etc., for the loss of fill or deterioration of concrete.

Areas of previous repairs, impact damage, honeycombing, scaling, and any other conditions indicating potential deterioration of concrete or rebars.

**Rating Examples**

Non-prestressed steel reinforced concrete members are rated based upon both degree of material deterioration and extent to which the member retains its original design structural capacity. Rate for distress exhibited in the member itself, not for problems related to other elements rated separately such as deteriorated pedestals, frozen bearings, or failed substructure columns.

7 - No spalling, scaling, cracking, efflorescence, etc., or other signs of deterioration. The primary members perform at full-design capacity. Original form lines or minor staining from rebar chairs do not affect the rating.

5 - Isolated minor scaling, spalling, delamination, or dampness. Isolated areas of minor cracking such as light map cracking or hairline tension cracks that do not compromise the primary member’s ability to function as designed.

3 - Extensive scaling, spalling, efflorescence, cracking, or delamination and possible exposed corroded rebars at isolated locations. The primary member system may no longer achieve its full original design capacity, although still reacting elastically to loadings. Extensive leakage with efflorescence and dampness are usual indicators of this condition. Bridge load capacity is affected.

1 - Severe or extensive deterioration rendering the primary member system potentially ineffective, i.e., it has lost almost all capacity to sustain the original design loadings.

Since the primary member rating represents the condition and functional capacity of the main members of the bridge span as a system, the sample photos below illustrate localized primary member ratings that may or may not represent the actual primary member rating for the span. If the condition depicted in the photo is the controlling condition in a load path non-redundant system, the rating would be used for the primary member system. Similarly, if the condition in the photo typifies the primaries in a redundant system, that rating would be used for the span being rated.
The pre-cast concrete arches are in like new condition. A few areas of surface mapcracking were noted since installation; most likely a result of the curing process.

Several of the concrete t-beams have mapcracking with moderate to heavy efflorescence. Rust stains indicate possible deterioration of internal beam reinforcement. Both the beam system and local beam deterioration rate 4.
Figure 7.2A.3 – Rate 3
This cast-in-place fascia beam exhibits severe spalling. The exposed longitudinal rebars exhibit minor section loss. One of the exposed stirrups is broken and the others have moderate section loss. No debonding from the core concrete was noted. Beam rates 3.

Figure 7.2A.4 – Rate 3
The cast-in-place concrete exhibits extensive spalling with exposed, moderately corroded reinforcement throughout the arch. Several areas of spalling exhibit debonded reinforcement.
7.2B – PRESTRESSED CONCRETE

What To Rate

Physical condition and functional capability of the primary members are rated under this element.

Rate flanges of precast T-beams and flanges of precast NEXT D beams with the primary member.
(Note: The NEXT F beam top flange is considered a deck forming aid, similar to an S.I.P. form, and is not considered in the primary member rating.)

Typical Prestressed Concrete Primary Members

- Box beams
- Voided slabs
- I-beams and T-beams
- NEXT D beams
- Box girders (segmental)

Figure 7.2B.1
What To Look For

Examine alignment, profile, and impact damage with all primary members. Inspect for and document any cracks in the members. Most cracks in prestressed beams are potentially serious since tensile forces exist that might not have been accounted for in the design. Vertical or diagonal tension cracks in prestressed members are signs that the prestressing steel (tendon) has failed or is failing, and the loads are being carried by adjoining beams. This is a serious condition and steps should be taken to ensure the stability of the bridge as soon as possible.

Generally, there are three main types of structural cracks (see Fig. 7.2B.2):

- **Web Shear Cracks:**
  Diagonal tension causes a crack at or near the support. These cracks typically extend up and away from the support at an approximately 30° angle (45° if not prestressed).

- **Flexural Shear Cracks:**
  Found between the support and maximum moment area. These cracks consist of both vertical and diagonal cracks occurring together.

- **Flexural Cracks:**
  Usually found in the vicinity of the maximum moment. These cracks are normal to the longitudinal axis and extend vertically through the tendon locations.

Additionally, cracks occur in the ends of prestressed members due to detensioning forces. These cracks generally can be seen across the beam end and/or along the sides and bottom at the end.

![Diagram of cracks](image)
When inspecting these types of structures, at a minimum, the following should be visually checked:

- Any sagging by individual members could indicate overloading or loss of prestress.
- Support area for diagonal cracking (shear).
- Deterioration at the end of the beam which can lead to loss of bearing area and local crushing of the remaining concrete, especially when there are low skews and short end of beam overhangs.
- Mid-span area (maximum moment) for flexural cracks.
- Between mid-span and bearing for flexural shear cracks.
- Longitudinal cracking at prestressing steel tendon levels.
- Horizontal deflections (sweep) may indicate asymmetric loading from either non-uniform prestressing forces or tendon failure.
- Spalled areas for exposed tendons.
- Shear keys for grout displacement and evidence of leakage.

In addition to the visual check, the following activities, at a minimum, should be performed:

- Sound the beams at the support area and mid-span location and any other areas showing deterioration.
- Evaluate and estimate or, if possible, measure any loss to exposed tendons and note location.
- Quantify debonded tendons and fully or partially broken tendons. Note these locations.
- Investigate previously repaired areas.
- Check drain holes and clear if clogged.
- Document findings with notes, photographs and sketches including full crack and deterioration documentation.

The two most common causes of losing prestressing forces are impact and corrosion. Generally, deterioration occurring in prestressed concrete members is evident to the inspector, but in some cases, serious but latent corrosion of the prestressing strands may exist without many outward signs of problems. Be sure to check for:

- Concrete delamination, hairline cracks, efflorescence or rust stains at the level of the prestressing strands, which can indicate strand corrosion.
- Longitudinal cracks in the beam may be the result of expansion forces caused by prestressing steel corrosion.
- Efflorescence, leakage, and staining indicate the likelihood of prestressing steel corrosion and a diminished load carrying capacity.
- Concrete delamination or spalling are more definitive signs of prestressing steel corrosion and diminished capacity.
- Check for tendon damage if any of the beams have been impacted. Cracks spreading from the damaged area indicate extent of prestress loss.
- Longitudinal cracks in the wearing surface may indicate that the shear keys of the primaries have failed or are not working as designed.
- Check drain holes on box beams for rust stains possibly indicating deterioration not visible until it becomes more serious. Plugged drain holes should be cleared to check for possible water accumulation.

Recent research has suggested that once outward signs of prestressing steel corrosion are visible, deterioration occurs very rapidly. The inspector should pay particular attention to areas where the
concrete is patched. In such cases, the Regional Structures office should try to get information on the condition of the prestressing steel from those who did the repairs. This information, if available, should be included in the BIN folder.

**Rating Examples**

Prestressed concrete primary members are rated on both physical condition and structural capacity as compared to the original design capacity. These are same criteria as reinforced concrete primary members. However, physical deficiencies (cracks, spalls) are usually more serious in prestressed members. The members are rated as a system.

7 - No spalling, scaling, cracking, or efflorescence. No signs of vertical or horizontal misalignment. Members show no physical limitations to perform at full-design capacity.

5 - Isolated scaling. Minor vertical deviations, but little or no leakage between adjoining members and only a few reflective cracks in the wearing surface. No indication of broken tendons.

3 - Web shear, flexural shear, and flexural cracks on isolated members indicate loss of strength in those members, and that the other beams are carrying the loads for these members. Leakage between adjoining members and reflective longitudinal cracks in the wearing surface indicate the members are not functioning as originally designed and could mean loss of prestress or overload condition. Efflorescence, delamination, and moderate spalling may indicate corrosion of tensioning strands or concrete deterioration. Bridge load capacity is affected.

1 - Web shear, flexural shear and flexural cracks on many beams indicate prestressed members are not functioning as originally designed. Horizontal deflections in members, vertical deflections, and/or severe or extensive deterioration (such as excessive deflection, tendon failure or spalling) indicate the system has lost much of its original capacity. The primary member system is ineffective in sustaining the original design loadings and may not be capable of safely supporting even minimum live loads.

Since the primary member rating represents the condition and functional capacity of the main members of the bridge span as a system, the sample photos below illustrate localized primary member ratings that may or may not represent the actual primary member rating for the span. If the condition depicted in the photo is the controlling condition in a load path non-redundant system, the rating would be used for the primary member system. Similarly, if the condition in the photo typifies the primaries in a redundant system, that rating would be used for the span being rated.
The prestressed concrete Northeast Extreme Tee (NEXT-D) beams are in like-new condition.

Efflorescence has developed between the beam flanges due to minor leakage. Otherwise, the beams are in good condition.
A few of the prestressed concrete beam bottom flanges are cracked longitudinally at midspan. Some cracks exhibit water leakage and efflorescence with localized staining from corroded reinforcement staining. Both the local condition and primary would rate 4.

As the result of possible overstress, tight transverse cracks (highlighted by chalk marks) extend across the bottom flange of the segmental box beam and into the web at midspan.
The bottom edge of the fascia beam is severely spalled. The outermost strand is broken and four adjacent exposed strands are estimated with 50% section loss. Shear key failure between several beams is apparent by leakage and longitudinal cracking in the wearing surface. Random spalling of interior beams occurs along hoop reinforcement. Both the localized and overall condition of the primary member system rate 3.

The beams’ undersides are wet, effloresced, and rust stained. Four out of seven beams are heavily cracked and deeply spalled with exposed reinforcement and prestressing strands. Several beams have broken prestressing strands in various locations.
What To Rate

Refer to Table 7.2-1

Typical Steel Multi-Girder Primary Members

Steel multi-girder bridges are load path redundant structures with four or more of any of the following types of members:

- Rolled beams (including concrete encased)
- Welded plate girders
- Riveted plate girders

What To Look For

Base the primary member rating on the girders' condition and their ability to carry the loads for which they were designed. Since they should be rated as a system, an important consideration is how any material deterioration or reduced capacity in individual structural elements affects performance of the bridge as a whole.
For non-encased steel members, look for corrosion and section loss, cracking of the base metal or welds, buckling, impact damage, signs of overstress, and condition of welds and rivets. Of primary concern should be the following:

- Corrosion and section loss, particularly of webs in high shear areas or flanges in high moment areas.
- Cracks in welds or girders in any tension or stress reversal area, most likely to occur at fatigue-prone locations where stress concentrations are high, at out-of-plane bending locations, impact damage sites, plug welds, or tack welds.
- Distortions in the girders caused by heavy loads, section loss, or impact damage.
- Crevice corrosion causing weld or rivet overstress.

For concrete-encased steel members, base the rating on condition of the concrete and any exposed portion of the girder. Look for signs of leakage through the concrete and for cracking, spalling, efflorescence, and rust staining. Use a masonry hammer to determine if the concrete encasement is delaminated.

See Appendix C for special emphasis inspection intensity requirements.

**Rating Examples**

7 - New or near new condition; no section loss, no distortions.

5 - Localized section loss or minor impact damage without cracks in the base metal, localized concrete encasement cracking and staining.

4 - Occasional minor cracks in weld metal only, or some small, stable cracks in the base metal of steel primary members in compression, but not widespread.

3 - Serious section loss, several cracks in base metal, but not yet critical, serious impact damage with cracks in the base metal, heavy concrete encasement cracking, spalling, and rust staining indicating section loss of the steel members. Bridge load capacity is affected.

1 - Critical base metal cracking, severe widespread section loss in high stress areas, severe impact damage to several adjacent members. The primary member system is ineffective in sustaining the original design loadings and may not be capable of safely supporting even minimum live loads.

Since the primary member rating represents the condition and functional capacity of the main members of the bridge span as a system, the sample photos below illustrate localized primary member ratings that may or may not represent the actual primary member rating for the span. If the condition in the photo typifies the primaries in a redundant system, that rating would be used for the span being rated.
The bottom flange encasements have superficial staining from the stay-in-place forms. This indicates only very minor girder corrosion.

The lightly corroded multi-girder bridge has minor localized section loss.
Moderate corrosion of the bottom flange caused the concrete encasement to crack and spall off. Full length cracks along the adjacent girders’ encasement indicate these girders also have similar corrosion. Rate the system 4.

The web bearing areas of several adjacent girders in spans 1 and 2 exhibit moderate section loss at the pier. Corrosion losses have been arrested by cleaning the steel and applying new paint. Prior to being repaired, span 2 web ends required a system rating of 3. Documented NYSPE certified web repairs allow up-rating of the girder system to 4.
Girder S2 has sustained severe impact damage. The bottom flange is torn near 1/3 span. The girder, located below a sidewalk and bicycle lane, does not carry direct traffic loads. The closely spaced, adjacent girders are not affected. Girder rates 1, system rates 3.

The girder flange is heavily corroded within the high moment area of the span. This condition has not changed significantly since the last inspection. This girder rates 2.
A crack in a girder web, near the bottom flange is a result from out-of-plane bending. This crack is over 2 inches in length and is considered a working crack likely to propagate. Rate PM 2 because multiple, similar defects were found on each girder of this redundant structure.

There is a severe crack in a fascia girder. The entire bottom flange is fractured near center span. The load capacity of this member is severely reduced. The system would rate higher.
7.2D – TWO AND THREE-GIRDER

What To Rate

Refer to Table 7.2-1

Typical Two and Three-Girder Primary Members

- Girder-floorbeam system
- Girder-floorbeam-stringer system

What To Look For

Just as for any primary member, check alignment and profile for deviation that could result in undesirable stresses.

- Check webs near supports at abutments and piers (including pin and hanger "piers") for any indications of crippling or section loss.
- Examine flanges in both compression and tension zones for corrosion and section loss.
- Spalled deck areas adjoining girders indicate that some section loss of the primaries should be expected. Girder webs adjoining sidewalks are also subject to accelerated corrosion and section loss.
Short or rusted scupper downspouts can concentrate road salts on bottom flanges and contribute to significant section loss.

Pin and hanger locations are especially prone to problems – give the primary members careful attention. Pin and hanger assemblies are rated as bearings, but malfunctions could reduce primary capacity.

Riveted, built-up members typical of thru-girder design are susceptible to crevice corrosion. Visually check the alignment for a ripple-like effect and note extent of rivet section loss or overstress.

Check for cracks in welds or girders especially at fatigue prone areas.

Check for poor details such as coped members.

INSPECTION INTENSITY: The non-redundancy of two/three girder structures alerts the inspector that inspection should be done with greater intensity than a multi-girder system. Hands-on inspection is required per Appendix C.

Rating Examples

Two/three girder primary members are rated on both physical condition and ability to handle original design loading. The same criteria exist for multi-girder primaries, but the condition of individual elements is more critical because there is reduced load path redundancy.

7 - New or like-new condition. No signs of section loss or distortions.

5 - Minimal section loss- member can still function at full capacity, little or no crevice corrosion. Damage from impact that does not reduce load carrying capability.

3 - Heavy corrosion with substantial section loss or impact damage resulting in a reduction of load carrying capacity.

1 - Severe and extensive section loss in critical areas or major impact damage resulting in a substantial reduction of load carrying capacity. Any crack in girder tension zone. The primary member system may not be capable of safely supporting even minimum live loads.

Since the primary member rating represents the condition and functional capacity of the main members of the bridge span as a system, the sample photos below illustrate localized primary member ratings that may or may not represent the actual primary member rating for the span. If the condition depicted in the photo is the controlling condition in a load path non-redundant system, the rating would be used for the primary member system. Similarly, if the condition in the photo typifies the primary members, that rating would be used for the span being rated.
Figure 7.2D.2 – Rate 6
The girder/floorbeam system has only spotty surface corrosion: no section loss.

Figure 7.2D.3 – Rate 5
Widespread surface corrosion is evident by rust bubbles, bleed through, and localized failure of the paint system. The section loss is minimal.
The thru-girder web stiffener has a corrosion hole at its base. The bottom flange and above web have surface corrosion with moderate section loss throughout the span.

Corrosion perforations exist at the web/sidewalk of the thru-girder. This condition rates 3.
The main girders, floorbeams, stringers and rivet heads are heavily and uniformly corroded. Significant section loss exists at critical areas. The bridge is posted for load.

There is severe crevice corrosion along the bottom flange at midspan of a recently rehabilitated 2-girder bridge. Locally, this condition rates 2. The system could rate higher.
7.2E – METAL TRUSSES

What To Rate

The most common truss type used for bridge construction is two-dimensional with members designed to withstand axial forces. The primary member rating is based on the ability of the superstructure to carry the loads for which it was designed. Truss members, floor beams, and their connections are generally non-redundant, and integrity of the entire superstructure system is dependent upon condition of each individual element. A single member or connection in poor condition can dramatically influence primary member rating for the affected span.

Refer to Table 7.2-1 for a list of bridge elements rated as primary members.

Typical Trusses

- Simple truss
- Continuous truss
- Pin-connected truss
- Pony truss
- Through truss
- Deck truss
What To Look For

All members and connections should be inspected for the following:

- **MEMBER CONDITION**
  Truss members are designed for axial forces. It is important to know whether a member acts in tension, compression, or both. Section loss in only one truss member results in loss of load carrying capacity for the entire truss. Likely areas of corrosion are around pockets that can hold debris and moisture, especially near bearings and within gusset plates at panel points. Debris should be removed to facilitate inspection. Corrosion can also occur between plates of built-up members. Check areas vulnerable to deicing salts such as lower chords, floorbeam connections, end floor beams and their connections to stringers.

  Damage can occur by direct impact or indirect impact transmitted by an attachment such as guiderail or overhead bracing. Impact damage may result from water borne channel debris and errant or over height/width vehicles. Check members closely for cracks and steel yielding near areas of impact or damaged attachments.

  Improper modifications to truss chords (such as plug welds) can greatly affect load carrying capacity by initiating cracks, especially for tension members. Check areas of welded repairs or attachments for undercut slag, porosity, or cracked welds. Check bolted retrofits for excessive section removal due to drilling, flame cutting or punching.

  Check for proper tension in truss rods. Looseness in one member may result in excessive force in another member. Listen for rattling and banging under live loading, as this is indicative of loose members. Pay particular attention as the live load passes from one panel point to the next.
Inspect the flooring system by the same criteria used for a flooring system in a two or three-girder system.

**ALIGNMENT**
Proper alignment of individual truss members can significantly affect their ability to carry axial loads.

Check truss alignment by sighting down the truss. Look for tilt, bends, kinks, dips, and sag. They may be signs of other problems not immediately evident. Check individual members for proper shape and position. Bowed or buckled compression members may severely reduce the capacity of the entire truss.

**OVERSTRESSED MEMBERS**
It is important to classify members as tension or compression members and those that may control truss capacity. Some may be over-designed for simplicity and to simplify construction.

Check for local or lateral buckling in compression members. Wrinkles or waves in flanges, webs, or cover plates may be signs of overstress. Check for necking down of cross-sectional area in ductile tension members. This indicates yielding steel before strain hardening occurs, and is usually accompanied by paint flaking. Higher strength steels may be less ductile than carbon steels. Overstress in a non-ductile tension member is difficult to recognize and failure may be sudden. Many early trusses were constructed of wrought iron with cast iron fittings at panel points. These members should be closely examined for small cracks and notches. Critical crack length for fracture may be very short.

Early eyebars were manufactured by forging eyes onto bar stock. Loop rods were made by bending and forging a loop into a straight rod. Eyebars and loop rods are tension members. Check their ends closely for forging discontinuities.

**CONNECTIONS**
Those between individual truss members and flooring system members may be critical to the integrity of the entire structure. Look for stress indications in the paint. Check for loose or missing pin caps, pin nuts, rivets, or bolts. Listen for noises with the passage of vehicles. Look for cracks in the web where flanges have been coped for connections. Check for section loss of threaded connections at the bolt-nut interface which can occur at turnbuckles and floorbeam hanger U-bolts. Eyebar and loop rod spacing at pins can greatly affect bending stresses in the pin. Look for corroded or missing spacers and bent pins. Check for corrosion at lower panel points, especially where deicing salts may wash onto trusses and connections.

**INSPECTION INTENSITY:** Bridge inspection intensity requirements are detailed in Appendix C. The Appendix identifies the structural components that must receive a 100 percent close-up, hands-on visual inspection during each biennial and interim bridge inspection.
**Rating Examples**

Consider ability of the entire system to carry the loads for which it was designed. A non-redundant member or connection in poor condition will greatly affect the load carrying capacity of the superstructure.

7 - New or near new condition; no significant deficiencies in truss members, floor beams, stringers, or connections.

5 - Corrosion with minor section loss, minor misalignments with little significant impact. Superstructure can safely carry the loads for which it was designed.

3 - Serious corrosion to one or more critical members or connections, corroded or missing bolts in one or more critical members. Ability of superstructure to carry design loading is reduced.

1 - Critical crack in any truss tension member or stress reversal member, severely impacted end post, severe widespread section loss in truss members, connections, floor beams and/or stringers, or severe truss member misalignment seriously reducing load capacity. The primary member system may not be capable of safely supporting even minimum live loads.

Since the primary member rating represents the condition and functional capacity of the main members of the bridge span as a system, the sample photos below illustrate localized primary member ratings that may or may not represent the actual primary member rating for the span. If the condition depicted in the photo is the controlling condition in a load path non-redundant system, the rating would be used for the primary member system.
Figure 7.2E.3 – Rate 5
The pony truss has localized minor corrosion along the bottom chord, gusset plate and vertical. Section loss is minimal with no effect on load carrying capacity.

Figure 7.2E.4 – Rate 4
The deck truss has widespread corrosion that is particularly evident along the bottom chord, gusset plate and the diagonal member web. Further section loss is likely to result in a reduced load capacity.
The truss end post was impacted. The channel flange is locally buckled, but the member overall is not out of alignment.

The truss bottom chord has severe localized section loss to the channel legs and web near a tie plate connection. Note that the condition of the tie plate is rated under secondary members.
Figure 7.2E.7 – Rate 3
There are holes in the web of a diagonal truss member.

Figure 7.2E.8 – Rate 2
The truss end post has severe section loss resulting in several holes in the web.
Figure 7.2E.9 – Rate 1
The truss gusset plate has extreme section loss with multiple perforations and little remaining steel. The plate is slightly buckled.

Figure 7.2E.10 – Rate 1
The top chord of the thru-truss has a loose splice plate. Note the loose rivets and the misalignment between the spliced top chord channels.
Figure 7.2E.13 – Rate 1
The loop bar after a dye penetrant test reveals a curved transverse crack in the bar.

Figure 7.2E.14 – Rate 1
The truss panel point is missing the retaining nut for the eyebar connection.
7.2F – TIMBER

Wood is an excellent material for bridge construction, with medium to high strength-to-weight ratio, and for short periods, it can handle a high degree of overstress (impact). Wood is readily available and wooden structures can be economical to build and maintain. Wood is resistant to attack from most chemicals.

Typical Timber Primary Members

- Glue-Laminated (Glulam) Girder
- Nail Laminated Deck Slab
- Solid Sawn Multi-Beam
- Timber Arch
- Timber Truss

What To Look For

Untreated wood is vulnerable to damage from fungi and insects. All wood is vulnerable to damage from checking and splitting because of drying and wetting cycles, and to damage from fire and exposure to extreme heat. Timber structures are also vulnerable to the more typical causes of damage such as normal wear, collision, and overload (crushing). Inspectors must be able to identify signs that damage has or is occurring, and assess its effect on the ability of the member to function as intended.

- DECAY
  This is a result of attack by microscopic organisms called fungi. Decay occurs when conditions of moisture content, oxygen level, and temperature are favorable. Pay special attention to areas where wood members are in direct contact with other members. Treating the wood kills the fungi and stops decay. Discoloration is often (but not always) evident in early stages. In later stages, decay causes easily noticeable changes in both wood color and texture. Later stages are accompanied by substantial decrease in structural capacity of the member, which must be reflected in the rating.

- INSECTS
  For some insects, wood is both a source of food and as a place of shelter. The most destructive is the termite. Other potentially destructive insects are powder post beetles, carpenter ants, and marine borers. Since most damage caused by insects is inside the wood members, often the only sign of damage is accumulation of sawdust at the base of the member or white mud shelter tubes indicating termites. The inspector may have to probe the member with an awl or other suitable tool to properly assess the extent of damage. Do not probe excessively, since probe holes will allow moisture penetration thus initiating decay. Tapping the member with a hammer can also detect hollow areas.

- FIRE/HEAT
  Remove any charred material and/or take core samples to determine extent of damage and section loss.
• **CHECKING/SPLITTING**
Checking results from rapid decrease in wood moisture content combined with moisture differential between the inner and outer portions of the member. Splitting is commonly called through-checking. A nominal amount of checking is considered when establishing basic working stresses, but excessive or cross-grain checks or splits that enter connection areas may be serious and require closer evaluation. Checks have less effect on strength of laminated members. Splitting could indicate possible overstressing.

• **WARPING**
This is caused by differential shrinking caused by uneven moisture loss. This can induce very high stresses into the wood.

**Rating Examples**

7 - New or near new condition; no decay and only minor discoloration, no evidence of insect damage, minimal checking/splitting, no evidence of fire damage.

5 - Minor deterioration but still functioning as designed; minor decay, no appreciable penetration, minimal insect damage or hollow sounding areas, moderate checking/splitting, 5 percent or less section loss caused by fire, no visual evidence of sagging or warping.

3 - Serious deterioration or not functioning as designed; loss of section more than 20 percent from any cause, isolated areas of deterioration as evidenced by awl penetration and hollow sound. Bridge load capacity is affected.

1 - Totally deteriorated; widespread decay or insect damage, broken connections, severe section loss, extensive splitting or severe impact damage. The primary member system is ineffective in sustaining the original design loadings and may not be capable of safely supporting even minimum live loads.

Since the primary member rating represents the condition and functional capacity of the main members of the bridge span as a system, the sample photos below illustrate localized primary member ratings that may or may not represent the actual primary member rating for the span. If the condition depicted in the photo is the controlling condition in a load path non-redundant system, the rating would be used for the primary member system. Similarly, if the condition in the photo typifies the primaries in a redundant system, that rating would be used for the span being rated.
Figure 7.2F.1 – Rate 6
The timber girders have only slight surface discoloration. The girders sound solid when tapped with a hammer and there is no awl penetration.

Figure 7.2F.2 – Rate 5
The timber arch top chord is moderately checked. Bridge capacity is not affected.
Several full length longitudinal slab timbers are broken near midspan and sagging slightly. Isolated areas of leakage between the timbers are evident by staining. Awl penetration is insignificant.

The glue laminated girder is comprised of several timber pieces which are delaminating from each other. The delaminations occur sporadically throughout the girder length and depth. Yearly tracking indicates the delaminations are worsening.
The timber stringers have large areas of checking, discoloration, and rot. Several areas can be penetrated with an awl to a depth exceeding 10%. The transverse timber attached to the bottom of the stringers and the timber diaphragms are rated as secondary members.

One of 4 longitudinal timbers compiling the right truss bottom chord is fractured. This represents a 25% loss of section for the member.
The timber multi-girder bridge, fascia girder is completely rotten through. The remaining, tightly spaced girders are damp, however not easily penetrated with an awl and are in overall good condition. Girder rates 1, the system may rate higher.

The underside of the timber slab span has extensive rotting and splitting. Many consecutive timbers have 100% section loss due to rot.
7.2G – STONE MASONRY ARCHES

What To Look For

Stone Masonry should be rated as a primary member only when it is structural masonry. Do not rate stone facades on concrete arches.

Some of the world's oldest bridges are stone masonry arches. In rating primary members, consider condition of the stone, condition of the masonry, and overall behavior of the arch and spandrel walls.

In assessing stone condition, look for weathering, splits, delaminations or cracks in individual stones, spalling, and crumbling.

Mortar should be examined for soundness, signs of leakage, and associated efflorescence, and percentage missing should be estimated. If the masonry was originally laid without mortar and it can be determined that it was added later for cosmetic reasons, give less weight to mortar condition in establishing the primary member rating.

The masonry arch and spandrel walls should be examined as a system for signs of distress such as moving or shifting stones, cracks, or splits through adjoining stones, and leakage that hastens deterioration. If movement has occurred, find out the extent and whether it is progressive or has stabilized by measurement and comparing to photographs.
**INSPECTION INTENSITY:** Stone masonry bridges can generally be inspected from the ground where the entire arch is visible. If deterioration is observed, closer inspection is necessary to sound with a hammer and assess the mortar condition.

**Rating Examples**

7 - New or near new condition; almost no sign of deterioration of stones or mortar, arch lines and spandrel wall lines are true and as-built.

5 - Occasional stones may be cracked, up to 10-25 percent of mortar may be missing, leakage may be occurring but not seriously or causing progressive deterioration, minor weathering of stones.

3 - Loss of a significant amount of mortar where it is structural, serious weathering of the stones, adjoining stones split, signs of slight movement along arch or wall lines, heavy leakage causing deterioration of stones and mortar. Bridge load capacity is affected.

1 - Significant stone movement so that arch stability is in question.

![Figure 7.2G.2 – Rate 5](image)

Localized leakage of the arch underside has caused efflorescence and moss buildup. A few joints have missing mortar. The stones are in good condition and are in proper position.
Figure 7.2G.3 – Rate 4
The arch barrel stones are weathered and a few are missing. Mortar in the joints is receding uniformly. Minor leakage is apparent from the buildup of white efflorescence.

Figure 7.2G.4 – Rate 3
The spandrel wall is displaced and bulged outward above the arch. The entire surface is laced with cracks and small unit-to-unit displacements along horizontal and vertical mortar lines.
The brick arch has lost up to 16 inches of depth. The surrounding bricks are loose and missing mortar. The bridge is posted and permanent barriers restrict traffic to one lane.

The begin right of the arch mortar is severely deteriorated and missing. Several deep voids are present where the primary member’s stones have fallen out. The spandrel wall above this location is also missing several stones and areas of mortar.
7.2H – OTHER BRIDGE TYPES

What To Look For

Other bridge types include suspension bridges, steel arches, cable stayed bridges, corrugated steel arches, a variety of proprietary bridge types, and structures retrofitted to carry loads in a manner different than the original design. For these bridges, the inspector must first determine the load path from the structural deck (or wearing surface if there is no deck) to the abutments or the piers. Members on this load path are primary members. An assessment must be made whether individual members are redundant or non-redundant.

Once the load path has been determined, condition of individual components should be assessed and a rating given that represents primary members in the span as a system. For steel and concrete members, look for the same signs of deterioration as described earlier in this chapter. The FHWA Bridge Inspector’s Reference Manual explains items to look for on suspension bridges, cable stayed bridges, and segmented concrete bridges. Other cables should be inspected for loose strands, signs of wear, and loss of section. Corrugated steel arches should be inspected in a similar manner as corrugated metal pipes (see Chapter 8).

INSPECTION INTENSITY: For load path non-redundant members, "hands-on" inspection is required. These areas should be noted and documentation of the hands-on inspection should be included in the special emphasis section (see appendix C). Other members should be inspected with intensity appropriate to adequately determine their condition and ability to function as designed.
7.3 – SECONDARY MEMBERS

These are members that brace or stiffen individual primary members against buckling, provide lateral or torsional rigidity to the primary system, or hold components of a primary member in proper relative position. Refer to Table 7.2-1 for a list of secondary members. Secondary members are connected to primary members but do not resist traffic loads. They do, sometimes, resist lateral forces such as wind.

What To Rate

The condition and ability to function are rated under this element. Include the condition of the connections. Rate the secondary members as a system relative to the primary member system and its level of load-path redundancy. For example, rate a secondary member deficiency lower if it adversely affects the performance of a truss member than one that affects a stringer in a multi-girder system.

Typical Secondary Members

Secondary members are normally constructed of metal, concrete, or wood. Some of the more common secondary members are:

- Diaphragms (except those attached to curved girders or directly supporting deck loads)
- Lateral bracing
- Portals
- Lateral and sway struts and sway bracing on through trusses
- Lacing bars, stay plates, and tie plates on trusses
- Knee bracing

What To Look For

Look for signs of overstressing, impact damage, cracking of the base metal or welds, improper alignment due to buckling, bowing, or kinking, deterioration, and excessive movement. Behavior of secondary members can best be observed with passage of heavy live loads. Determine the cause of any unusual sounds or excessive movements.

For concrete members, inspect for scaling, spalling, delamination, cracking, efflorescence, dampness, staining, exposed rebar or tendons, or other signs of concrete deterioration. Sound concrete with a hammer.

For prestressed concrete box beams tied together laterally with post-tensioned tie rods or strands, the transverse ties are not considered secondary members. If no external diaphragms exist, secondary members should be rated 8.

For steel members, inspect for loss of section due to corrosion, cracking, improper alignment, and for secure connections (welds, bolts, and/or rivets).

For timber members look for decay, insect and fire/heat damage, checking/splitting and warping.
The actual location of secondary members and the details of connection of secondary members should be compared and verified against existing plans or sketches in lieu of plans. Variations observed between field conditions and plans/sketches should be noted on the plans/sketches.

Erection aids such as rebars attached transversely across the bottom flanges of stringers of jack arches, either by bent up hook or tack weld are not considered secondary members.

**Rating Examples**

**Timber:** see Chapter 7.2F for guidance.

7 - **Steel:** No section loss due to corrosion, connections are sound, and the alignment of bracing is good. No unusual sounds or excessive movement under live load.

**Concrete:** No spalling, scaling, cracking, efflorescence, etc., or other signs of deterioration. No unusual sounds or excessive movement under live load.

5 - **Steel:** Minor bends or misalignment due to impact damage. Negligible section loss of members or connectors (rivets, bolts, or welds) due to corrosion.

**Concrete:** Isolated moderate surface scaling or minor spalling with negligible efflorescence. Hairline cracking associated with minor mapcracking or isolated tension cracking that does not compromise the member's ability to function as designed.

3 - **Steel:** Serious deterioration or loss of functional capacity due to corrosion, improper erection, improper repair, impact damage, or misalignment. Some limited functional capacity may exist.

**Concrete:** Pervasive scaling/spalling/efflorescence/cracking and possible exposed corroded rebar with section loss with hollow sounding areas at many locations. The members may still retain a limited ability to function as designed.

1 - **Steel:** Members ineffective due to severe section loss of members or connections, or from severe impact. Large movements observed with the passage of heavy live loads.

**Concrete:** Members ineffective due to severe cracking, deep spalling, pervasive exposed corroded rebar with severe loss of section, and severe hollow sound/delamination at many locations.
The staggered diaphragms are in excellent condition.

The concrete diaphragm’s top face is partially spalled with no exposed reinforcement or rust stains. No other deficiencies are present. The adjacent utility supports are not considered in this rating.
Figure 7.3.3 – Rate 4
The batten plates and a bottom lateral connection plate have areas of severe section loss in isolated locations.

Figure 7.3.4 – Rate 4
The lower horizontal lateral bracing timbers were noted to be damp with surface fibers breaking down. Minor surface decay allows awl penetrations.
Figure 7.3.5 – Rate 3
The nearest diaphragm is severely rusted. There is a hole in the web bottom at the left girder connection. This diaphragm would rate 1; however, the diaphragm system is in considerably better shape and rates 3.

Figure 7.3.6 – Rate 2
The truss sway frame is severely damaged from impact.
7.4 – SUPERSTRUCTURE PAINT

7.4A – NON-WEATHERING STEEL

STEEL

What To Rate

Rate the physical condition of the paint or protective coatings of the steel bearings and steel superstructure excluding railings, signs, lighting or utilities.

Typical Paints and Coatings

Paints vary primarily with age of the bridge. Older steel bridges were protected either with oil/alkyd paints, concrete or mastic-like coatings. More recently constructed steel bridges use hot dip-galvanization, or coatings such as polyurethane or epoxy. Rehabilitated structures often have an organic epoxy coating covering a lead-based paint. Aliphatic, polyurethane, and organic epoxy coatings are used because they are free of lead and chrome. Newer types of paint include vinyl and latex. Zinc-rich paints are used as primers.

What To Look For

Inspect paint and/or coating for signs of chalking, alligatoring (checking), cracking, blistering, holidays (thin areas), pitting, saponification (alkaline chemical attack), loss of adhesion, wrinkling, or other deterioration. Application defects often include thin areas, scrapes, and peeling (lack of adhesion) due to improper surface preparation or handling. Thinner areas of paint or coating are noticeable due to differences in appearance such as coloring or shading.

Knowing where to inspect is as important as knowing how to inspect. Paint or coating deterioration typically starts in a few characteristic places, then spreads to adjoining areas. Areas to inspect for initial deterioration are at rivets and bolts, sharp edges or corners, moisture retention locations (example, at sand and salt accumulations), roadway splash zones and at hard-to-reach areas.

The paint rating should reflect the condition of the current paint or protective coating system. Existing section loss in the base metal after painting should be reflected in the primary or secondary member rating.
Rating Scale for Paint

7- The paint or coating system is in new or like-new condition. Galvanized steel surface is hard and either shiny spangled or dark gray matte finish in appearance.

6- The paint or coating system is in generally good condition with isolated areas requiring touch-up, such as along top flanges adjoining stay-in-place metal deck forms or in roadway splash zones. There may be some thinner areas of paint/coating. Isolated areas of wrinkling due to excessive paint thickness or temperature during application might be observed.

5- The paint or coating system shows signs of deterioration at isolated locations. Typical signs of deterioration include peeling of the finish coat, bleeding with localized areas of rust staining, alligator cracking, and chalking. Galvanized steel surfaces show signs of localized sacrificial action in the uppermost free zone layer especially at minor scrapes or shallow scratches.

4- The paint or coating system has localized areas in poor condition. Bleeding of soluble pigments from the undercoat, peeling, minor blistering, and/or light pinpoint rusting may be present. Reconditioning normally would require local sand blasting and touchup. Galvanized steel surfaces have undergone sacrificial loss usually observed as dulling of the once shiny surfaces. Surface texture is dull and matte-like throughout with localized areas of base steel exposed by scratches or scrapes.

3- The paint or coating system is generally in poor condition throughout the structure. Many areas of peeling, blistering, bleeding, chalking, shallow pinpoint rusting, rust undercutting at scratches, and surface scale are common. Reconditioning would require the entire superstructure be sand blasted, cleaned, primed, and re-painted/re-coated. Galvanized steel surfaces have lost much of the free zinc layer with noticeable stains at scratches, loss of shine, and a general dull matte finish.

2- The paint/coating is often peeling, chalking, and/or bleeding and very widespread. Galvanized steel surfaces have little or none of the uppermost free zinc layers with serious loss of the underlying zinc-iron alloy layers. Localized areas of the base steel are exposed.

1- Large areas have no paint/coating remaining and where it is present, paint/coating is faded, peeling, and/or chalking. Galvanized steel surfaces have many areas of exposed corroded base steel. Little or none of the free zinc or zinc-iron alloy layers remain at many locations. Severe embrittlement of remaining zinc layers is present.
The paint is in new condition.

The repainted members have paint nearly in like-new condition. The underlying section loss is reflected in the primary and bearings ratings.
Figure 7.4A.3 – Rate 5
The paint is faded and chalked with isolated minor steel corrosion.

Figure 7.4A.4 – Rate 4
The concrete coating is extensively delaminated due to expansive rust on the steel girder.
Figure 7.4A.5 – Rate 3
The paint is in poor condition throughout the span.

Figure 7.4A.6 – Rate 1
The corrugated metal culvert’s galvanizing is in very poor condition below the high water line, resulting in loss of section and perforation of the steel. The rest of the barrel galvanizing is in good shape.
7.4B – WEATHERING STEEL

What To Rate

Rate the effectiveness of the iron oxide coating (patina) on the steel bearings and steel superstructure excluding railings, signs, lighting or utilities. The effectiveness should be determined based on the color and texture of the surface of the steel.

Theory Of Weathering Steel

"Weathering Steel", first used by NYSDOT in the early 1970’s, refers to a carbon base steel that is alloyed with approximately 2% copper, nickel, chromium, and silicon. These additions are intended to inhibit the steel's natural tendency to continuously rust in the outside environment. When used in a suitable environment, this steel eliminates the need for painting because the steel "weathers" to form a patina, or thin layer of protective oxide coating, that prevents or minimizes further rusting. The patina will not form properly if the steel remains wet for extended periods of time or is contaminated with salt or other chemicals, especially if the bridge is exposed to these conditions soon after construction. Patina formation time will vary according to many factors and may take 2-3 years or more to form completely. If the patina has not properly formed, the steel will continue to corrode. This will appear as either continuous flaking of the plates and/or by plate delamination. The plate delamination will appear as open cracks along the vertical edges of the flange plates or by blistering (bulging) on flat surface areas.

What To Look For

Inspect the formation of the patina by observing its color and texture. The color of a properly formed or forming patina will vary with the age of the steel and its chemical composition. Generally, the color will change over time from light yellow orange to dark chocolate or purple. An improperly formed patina will generally appear dark black. A properly formed patina has tight mill scale or a tight granular consistency which will not be adversely affected by vigorous brushing with a wire brush. An improperly formed patina will generally have flakes and/or delaminations which can be removed with a hammer tap, a wire brush or chipping hammer.

Section loss in the base metal of the steel members should principally be indicated in the primary or secondary member rating.
Rating Scale for Paint (Patina)

7- The patina is tight. The color of the surface will range from light yellow orange (new steel) to dark chocolate or purple (steel exposed under good conditions with proper wetting and drying cycles). The texture of the surface is either mill scale or granular in nature, both adhering tightly when subjected to vigorous wire brushing. Some minor loss of the mill scale or granular surface material is normal under vigorous brushing.

6- The patina is generally tight with proper color and texture as described for the 7 rating on the majority of the surface. Isolated areas (e.g. under bridge joints) may have different darker colors or non adhering textures. This may be the early signs of future problems or just portions of the patina forming at different rates.

5- The overall surface may show signs of possible patina formation problems. The surface contains portions that are dark black indicating that the protective oxide layer is not forming. The surface in these isolated areas has a coarse texture or is granular with small flakes (under ¼ inch dia.) that are not adhering when subjected to a vigorous wire brushing.

4- The surface is typically dark black indicating that the protective oxide layer is not forming and probably will not form. The surface also typically has a coarse texture with non-adhering small flakes (under ⅛ inch dia.) and may have some evidence of plate delamination. There may be continuous rusting evidenced by occasional accumulations of flakes on the top of the bottom flange or on the ground or by the ability to remove much of the flaking with vigorous wire brushing.

3- The surface is uniformly dark black indicating that the protective oxide layer has not formed. The surface has a coarse texture that is principally non-adhering medium flakes (under ½ inch dia.) with some plate delaminations. There is continuous rusting of the steel evidenced by frequent accumulations of flakes or sheet delaminations on the top of the bottom flange or on the ground or by the ability to easily remove much of the flaking and delaminated sheets with a wire brush or chipping hammer.

2- The majority of the surface is black, indicating a significant failure of the protective oxide layer formation. The surface has a coarse texture that has large flakes (greater than ½ inch dia.) with little or no adhesion and there is extensive plate delamination. There is continuous rusting of the steel evidenced by consistent and extensive accumulations of flakes or sheet delaminations on the top of the bottom flange or on the ground or by the ability to easily remove much of the flaking and delaminated sheets with a wire brush or chipping hammer. These are indications that advanced section loss may have taken place.

1- The entire surface is black indicating a complete failure of the protective oxide layer formation. The entire surface has a coarse texture of large flakes (greater that ½ inch dia.) that demonstrate no adhesion and there is significant plate delamination. There is continuous rusting of the steel evidenced by consistent and extensive accumulations of flakes or sheet delaminations on the top of the bottom flange or on the ground or by the ability able to easily remove much of the flaking and delaminated sheets with a wire brush or chipping hammer.
Figure 7.4B.1 – Rate 7
The light orange-colored, tight patina of new steel is in excellent condition.

Figure 7.4B.3 – Rate 5
The bridge was placed in service several years ago. The overall surface shows signs of patina formation problems with dark orange protective oxide forming intermittently throughout.
Figure 7.4B.2 – Rate 4
Most of the steel is dark black with a rough texture indicating the weathering patina has improperly formed. A small percent of the steel, orange in color, has the proper patina. Intermittent patches of corroded sheet delaminations are forming throughout the structure.

Figure 7.4B.4 – Rate 3
The surface has a uniform coarse texture that is principally non-adhering medium flakes. There is continuous rusting of the steel made evident by the ability to easily remove much of the flaking with a wire brush or chipping hammer.
7.5 – SUPERSTRUCTURE JOINTS

What To Rate

Joints in the deck at piers and above hangers for suspended spans are rated under this element. On multi-span structures, the joint at the end of the first span is rated with the first span of the bridge, and the joint between the second and third spans is rated with the second span of the bridge, etc.

Always rate this 8 (not applicable) for the last span of the bridge since the joint at the end of the last span is the abutment joint.

Rate this 8 when there is no joint in the structural slab at the end of a span, as on a continuous structure.

Rating

Superstructure joints are rated in the same manner as joint with deck for abutments. See Chapter 4, Section C.2.
7.6 – SUPERSTRUCTURE RECOMMENDATION

What To Rate

This is the rating used to describe the superstructure's overall condition and the ability to function on an individual span basis. It should be based on the ratings for all the elements comprising Superstructure Elements. Do not include the superstructure paint condition in the superstructure recommendation. This number will normally reflect the rating for deck, primary and secondary members, and joints, but it does not necessarily have to be the lowest of these ratings.

Ratings

The inspector evaluates the system comprising the Superstructure Elements by using the rating number that best describes his opinion of the system's condition and ability to function.

8 - NOT APPLICABLE
7 - NEW CONDITION
6 - Used to shade between 5 and 7
5 - MINOR DETERIORATION BUT FUNCTIONING AS ORIGINALLY DESIGNED
4 - Used to shade between 3 and 5
3 - SERIOUS DETERIORATION OR NOT FUNCTIONING AS ORIGINALLY DESIGNED
2 - Used to shade between 1 and 3
1 - TOTALLY DETERIORATED, OR IN FAILED CONDITION
Superstructure

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CHAPTER 8
BRIDGE SIZE CULVERTS

8.1 - WHAT TO RATE: THE PRIMARY MEMBER
8.2 - WHAT TO RATE: OTHER ELEMENTS
8.3 - METAL CULVERTS
8.3 - CONCRETE CULVERTS

Introduction

The term culvert as used throughout this chapter is limited to any culvert large enough to meet the legal criteria defining a bridge, as stipulated in the Uniform Code of Bridge Inspection (see Appendix A). To be a single-span bridge, the span must be greater than 20 feet. Multiple pipes are bridges when the sum of all spans, plus spaces between them, is greater than 20 feet and each inter-span space is less than half of the smallest adjoining span diameter. These dimensions are measured along the centerline of highway.

8.1 – WHAT TO RATE: THE PRIMARY MEMBER

This chapter is divided into two sections. The first describes metal culverts that are flexible, and therefore rely on the interaction of the culvert and the surrounding soil. Because of this flexibility, the shape, and more importantly, the change in shape of the culvert over time indicate the primary member condition. The second section of this chapter covers concrete culverts that are rated solely on the condition of the materials and alignment of the elements.

For all culverts, concrete or metal, rate physical condition and functional capability of primary members and connections between primary members. For the primary member rating, consider also elements that contribute to strength and service life of primary members, such as the supporting soil, bracketing headwalls, etc.

For round or elliptical concrete or metal culverts, the entire pipe or barrel is the primary member. Because of soil involvement, the soil condition is part of the primary member's rating and the culvert's General Recommendation. This also applies to headwalls and cut-off walls if they retain backfill material that interacts with the culvert. Note that for metal culverts, the only superstructure elements rated are "primary member" and "paint."

For concrete box culverts, however, rate only the upper slab as the primary member. Rate other elements of concrete box culverts as stems, piers, and footings as described in other chapters of this manual.
8.2 - WHAT TO RATE: OTHER ELEMENTS

Inlet and outlet aprons or end sections are scour protection devices, therefore they should be rated as stream channel bank protection.

Slope protection placed on the embankment fill around the pipes is rated under approach embankment.

If aprons, headers, or end sections have attached walls that retain embankment not directly involved with culvert-soil interaction, these walls may be rated as abutment wingwalls.
8.3 - METAL CULVERTS

Shapes and Sizes

Metal culverts generally are corrugated and may be multi-plate or of one-piece construction. External concrete longitudinal stiffeners or metal transverse stiffeners are often added to strengthen the flexible barrel and/or improve distribution of compressive backfill forces.

Extensive dimensional details on span, thickness, etc., are available from industry publications such as those published by the American Iron & Steel Institute and the Aluminum Association.

The Time Rate-Of-Change of Dimensions

Metal culvert deformation often occurs during installation. Some variations between in-place measurements and the culvert's design values may be acceptable, if the changes have occurred mainly during compaction of fill. However, if dimensional changes are actively occurring, even if measurements are the same as initial design values, there is a problem.

Although changes in dimensions are important, for metal culverts, the rate of change is more important than amount of change.

Routine Measurements

There must be enough measurements taken routinely, to have a meaningful database so that any future deformations can be compared to previously recorded dimensions at or at least near the location of the deformation. Cross-section measurements must be taken and recorded at locations along the barrel, spaced close enough to ensure detecting changes from one inspection to the next. The dimensions AD, BE, AF, FE, and CF in Figure 8.1.2 are the minimum set of measurements required at intervals not greater than approximately 50 feet, but no fewer than three locations along the barrel of the culvert. These dimensions are defined by the actual location of bolt rows. If there is no line of bolts at C, measure to the corrugation peak at the highest point at the cross-section, and so note in the inspection report.

Permanent reference points are essential to ensure that the measurements can be accurately repeated in future inspections. If permanent reference hooks were installed during construction, they may be used and should be compared to any dimensions that may be included in the as-built plans, if available. If permanent reference hooks do not exist, the inspector should use reference points such as bolt ends that should be permanently marked as reference points. A precise description of the reference points must be provided in the inspection report. This description needs to give future inspectors the exact location of the reference points and clearly define to what part of the bolt, nut or hook the measurements should be taken. Station numbering or longitudinal dimensions locating the sections where barrel dimensions are taken should start at the left of the bridge looking in the direction of orientation.
Problem-Area Measurements

In addition to the routine measurements taken at regular intervals along the length of the barrel as described above, field measurements as shown in Figure 8.1.2 are required where any of the following conditions exist:

- The section is not symmetrical.
- There is noticeable sag in the top arch (an extreme case might even display reverse curvature because of partial collapse.)
- There is significant distortion and/or deflection.

The Team Leader will decide the number and spacing of additional cross-section measurements as warranted by field observations.

Any distortion in the upper 2/3 of the circumference is always significant, and always critical to the structure’s safety. In the lower 1/3, distortion is also always significant, but may not be critical to safety.

Special Cases

Some culverts that are very long, very high, submerged, or in some other way present unusual problems in obtaining barrel measurements may need to be evaluated in ways that are different from the approach used for most culverts. Such special cases should be judged on a case-by-case basis by the Regional Structures Management Engineer. Factors to be considered include safety, cost of special access, depth of fill, age and condition of the culvert, soil ph, hydraulics, etc.

A, B, C, D and E ARE BOLTINES. IF NO BOLT LINE AT C, USE THE HIGHEST POINT AT CROSS-SECTION. F IS LOCATED BY DROPPING A VERTICAL FROM C. CROSS SECTION IS SHOWN LOOKING FROM BRIDGE LEFT TO BRIDGE RIGHT, THUS POINT ‘A’ IS AT BRIDGE ENDS AND POINT ‘E’ AT BRIDGE BEGINS.

TYPICAL METAL CULVERT CROSS-SECTION DIMENSIONS

Figure 8.1.2
RATING METHODOLOGY FOR "PRIMARY MEMBERS"

There are several factors to consider when evaluating a metal culvert. Since the condition of a metal culvert is generally reported by a single rating for "primary members", it can be useful to rate each of these subordinate factors by using the standard 1 through 7 rating scale. Each factor has a weight relative to the overall condition of the culvert that will vary from culvert to culvert depending on culvert type, construction details, and field conditions. The factors to consider when rating the Primary Members for metal culverts are:

- Upper arc drop
- Localized deflection (shape)
- Leaning
- Barrel condition
- Seam condition
- Headwall condition
- Cut-off Wall condition
- Backfill

Each factor should be evaluated and can be given a condition rating ranging from 1 through 7 using the standard rating scale. These factor ratings are used in determining the "primary member" rating, and should be included in written remarks in the inspection report. The General Recommendation for the bridge should follow the same methodology. Details of what to look for in evaluating these factors are provided below.

UPPER ARC DROP

This refers to the flattening effect of vertical loads on the upper arc of the culvert. A corresponding effect is bulging of horizontal dimensions, increasing the span AE.

Measure CF and calculate the percent change from initial baseline value.

<table>
<thead>
<tr>
<th>Ordinate % Change</th>
<th>Depth of Cover &lt; 6 ft</th>
<th>Depth of Cover &gt; 6 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 15%</td>
<td>6-7</td>
<td>6-7</td>
</tr>
<tr>
<td>15% to 20%</td>
<td>4-5</td>
<td>5-6</td>
</tr>
<tr>
<td>20% to 25%</td>
<td>2-3</td>
<td>3-4</td>
</tr>
<tr>
<td>25% to 30%</td>
<td>1-2</td>
<td>2-3</td>
</tr>
<tr>
<td>Over 30%</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
LOCALIZED DEFLECTION (Primary Member)

This reflects the extent of shape irregularity. It includes kinks, dings, peaking, flattening, and inversion (an extreme case of flattening). Inversion is the formation of reverse curvature, usually seen at the top, it may also occur at the bottom. When localized deflection occurs, leaning may also be present. Measurements AD and BE may be useful in quantifying the degree of localized deflection.

**FACTOR RATINGS FOR LOCALIZED DEFLECTION (SHAPE)**

<table>
<thead>
<tr>
<th>Observations:</th>
<th>Factor Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has good appearance, with smooth, symmetrical curvature.</td>
<td>Gravel 7</td>
</tr>
<tr>
<td></td>
<td>Silt/Clay 7</td>
</tr>
<tr>
<td>Curvature is generally smooth but with some slightly non-symmetrical sections, and/or top arch has noticeable sag.</td>
<td>5-6</td>
</tr>
<tr>
<td></td>
<td>5-6</td>
</tr>
<tr>
<td>Significant distortion and deflection exist in one section and the top arch shows slight flattening.</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Significant distortion and deflection exist throughout the structure.</td>
<td>2-3</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Extreme distortion and deflection exist in one section.</td>
<td>1 –2</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Extreme distortion and deflection exist throughout the structure.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Structure is partially collapsed; arch is either flat or has a reverse curve.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
LEANING

Leaning is a shift of the vertical centerline to an inclined position. In Figure 8.1.2, percent leaning is defined as:

\[
\text{Percent Leaning} = \frac{AF - FE}{AE} \times 100
\]

The leaning factor rating guidelines below are for static conditions. If leaning is dynamic, use lower factor ratings.

**FACTOR RATINGS FOR LEANING**

<table>
<thead>
<tr>
<th>Percent Leaning:</th>
<th>Factor Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For Span &lt; 12 feet</strong></td>
<td><strong>For Span &gt; 12 feet</strong></td>
</tr>
<tr>
<td>0 to 4</td>
<td>0 to 2.5</td>
</tr>
<tr>
<td>4 to 8</td>
<td>2.5 to 5.0</td>
</tr>
<tr>
<td>8 to 12</td>
<td>5.0 to 7.0</td>
</tr>
<tr>
<td>12 to 16</td>
<td>7.0 to 10.0</td>
</tr>
<tr>
<td>16 to 20</td>
<td>10 to 12.0</td>
</tr>
<tr>
<td>20 to 25</td>
<td>12.0 to 15.0</td>
</tr>
<tr>
<td>Over 25</td>
<td>Over 15</td>
</tr>
</tbody>
</table>
BARREL CONDITION

What To Look For

Metal culverts can fail as a result of metal loss without any noticeable prior deflection. For this reason, inspection for section loss by corrosion or abrasion needs to be given a high priority. Compare section loss with design thickness. If there is excessive corrosion, note the location(s) in the inspection report with a recommendation for further investigation and/or a flag as appropriate. Document the water level in pipe at time of inspection (i.e., 1/4 full, 1/2 full, etc.), and if it appears that water level is constant or varies throughout the year. This will help in judging the extent of corrosion. The locations of corrosion need to be noted in the inspection report. Metal loss due to corrosion above the lower quarter points is much more critical to the stability of a culvert than similar metal loss in the invert. When serious corrosion is observed or suspected, it may be necessary to call for further investigation to better quantify the extent of section loss.

FACTOR RATINGS FOR BARREL CONDITION

<table>
<thead>
<tr>
<th>Observed Barrel Condition:</th>
<th>Factor Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generally good condition; no noticeable corrosion or other defects</td>
<td>7</td>
</tr>
<tr>
<td>Minor defects and/or damage exists; some superficial corrosion is present, with no pitting.</td>
<td>5-6</td>
</tr>
<tr>
<td>Fairly severe corrosion exists at certain locations, with slight pitting.</td>
<td>4.5</td>
</tr>
<tr>
<td>Fairly severe corrosion exists at certain locations, with moderate pitting.</td>
<td>4</td>
</tr>
<tr>
<td>Severe local corrosion and pitting exists.</td>
<td>2-3</td>
</tr>
<tr>
<td>Severe corrosion and pitting exists throughout the structure.</td>
<td>2</td>
</tr>
<tr>
<td>The barrel has sufficient corrosion to be potentially hazardous.</td>
<td>1</td>
</tr>
</tbody>
</table>
SEAM CONDITION

Check for tightness of seams between plates and between longitudinal sections. Note broken, loose, rusty, or missing bolts. Look for signs of leakage through seams.

Check for cracks, paying particular attention to bolt locations. The areas requiring the closest scrutiny are bolt locations at haunches and quarter points. Mark the end of cracks and document their lengths so comparisons can be made to determine their change or growth.

FACTOR RATINGS FOR SEAM CONDITION

<table>
<thead>
<tr>
<th>Observed Condition:</th>
<th>Factor Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seams are correctly assembled and tight; bolts are also tight.</td>
<td>7</td>
</tr>
<tr>
<td>Minor cracks exist at a few bolt holes; minor cracks may possibly allow some infiltration.</td>
<td>5-6</td>
</tr>
<tr>
<td>Major crack exists at a single location, bolts are loose, or soil infiltration has caused slight deflection.</td>
<td>4-5</td>
</tr>
<tr>
<td>Significant cracking has occurred along much of the seam, soil infiltration has caused considerable deflection of the barrel.</td>
<td>4</td>
</tr>
<tr>
<td>Cracks up to 3 inches long exist beside a given bolt hole, significant number of bolts are missing, infiltration has caused severe local deflection.</td>
<td>2-3</td>
</tr>
<tr>
<td>Cracks are prominent, reaching from one bolt hole to another, significant infiltration exists throughout.</td>
<td>2</td>
</tr>
<tr>
<td>Cracks exist all along the seams, backfill has pushed into the structure.</td>
<td>1</td>
</tr>
</tbody>
</table>
HEADWALL CONDITION

What to Look For

Characteristics of the concrete in headwalls are similar to those of concrete in culverts. Refer to paragraphs on cracks and spalling. Stone headwalls may exhibit settlement or gaps from missing stones or mortar. Look for excessive localized loads deforming the culvert and loss of embankment retention.

FACTOR RATINGS FOR HEADWALL CONDITION

<table>
<thead>
<tr>
<th>Observed Condition:</th>
<th>Factor Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions like new, no hollows, cracking, spalling, slabbing, delamination, chipping, nor settlement.</td>
<td>7</td>
</tr>
<tr>
<td>Minor headwall settlement and pulling away from the barrel are noted; minor hairline cracks are found.</td>
<td>5-6</td>
</tr>
<tr>
<td>Extensive undercutting and significant settlement of the headwall are noted; moderate cracking is found.</td>
<td>4-5</td>
</tr>
<tr>
<td>Major undercutting and extreme settlement is noted; considerable deterioration is found.</td>
<td>3-4</td>
</tr>
<tr>
<td>Undercutting is so severe that the headwall has started to rotate away from the barrel; major deterioration throughout the headwall is noted.</td>
<td>2-3</td>
</tr>
<tr>
<td>Significant rotation of the headwall from the barrel is obvious; spalling/cracking has occurred, along with associated deflection of the structure.</td>
<td>1-2</td>
</tr>
<tr>
<td>Severe movement of the headwall as a result of undercutting and settlement; severe deterioration and damage to the structure is noted.</td>
<td>1</td>
</tr>
</tbody>
</table>

BACKFILL

Consider this parameter only when there is evidence that barrel dimensions are undergoing significant dynamic changes.
THE SOIL COVER

The soil covering loads the culvert, but also has a beneficial load-distributing effect. Culverts with shallow cover are subjected to greater live-load stress than other culverts. The inspector should document the approximate soil cover at each culvert.

SUMMARY: RATING A METAL PRIMARY MEMBER

All factors discussed above contribute to adequate performance of the primary member, and thus need to be considered in its rating. The "primary member" rating may often be the lowest factor rating, but this may not always be the case. The performance of the culvert is a result of the interaction of all factors. These factors play roles of different importance depending on observed behavior, condition, geometry and site conditions. The relative importance of these factors is therefore subject to the judgment of the Team Leader when rating "primary members" and the General Recommendation for the bridge.
**8.4 - CONCRETE CULVERTS**

These are rigid structures and do not deflect appreciably before cracking or fracturing. Shape inspections, while important in flexible structures, have little value in inspecting concrete culverts. Also, soil stability and side support are less important for concrete culverts than flexible ones. However, surrounding soil must be stable to prevent settlement and carry loads. Inspections, thus should concentrate on possible defects in alignment, joints, and walls.

**What to Look For**

**Visual Check:** All components of culvert barrels should be visually examined, including walls, floor, top, and joints. Sound the concrete with a hammer, particularly around cracks and other defects.

**Misalignment:** Check the barrel's vertical and horizontal alignment by sighting along the crown and sides. Check for differential movement or settlement at joints between sections. Check vertical alignment for sags, heaves, and faults. Check for sags during low flow. Look for spots with deep water or where sediment has been deposited. Misalignment may result from serious problems in the supporting soil, if due to improper installation or uneven settlement, further inspections may be needed to determine whether the condition is dynamic.

**Joints:** Defects are common and some may be serious. Typical joint defects include cracks, joint separation, and leakage (exfiltration and infiltration). Note: some water leakage through the side wall joints was expected in culverts designed without weep holes. Spalled or cracked joint edges may indicate expansion joints that are not functioning or full of incompressible materials. Identify any joints that are opened wide or are not uniform in width. Infiltration or exfiltration should also be noted. Separated joints may be caused by the same forces as misalignment, and are significant because they may accelerate leakage damage, causing erosion of backfill material.

**Cracks:** Location, size, and length or area of all cracks and spalls should be noted.

**Spalling:** Spalls often occur along cracks. Delaminations that are likely to become spalls may be detected by tapping with a hammer. These delaminations produce a hollow sound when tapped.

**Slabbing:** Slabbing or slab shear refers to radial failure of concrete and occurs from distortion of reinforcement by excessive deflection. It is characterized by chunks of concrete shearing from the sides of the pipe. This is a serious problem that may occur under high fills.

**What to Rate**

For box culverts, rate the top slab as a primary member. Rate the walls as abutment stems, or piers. Rate the bottom slab as abutment or pier footings.

For circular pipes, pipe arches, ellipses or any other round shape, rate the entire barrel as primary members.

For arches, rate the arch as primary members. Rate the thrust blocks as abutment footings or pier footings.
This chapter includes the following rating elements:

9.1 - LIGHTING
9.2 - SIGN STRUCTURES
9.3 - UTILITIES AND UTILITIES SUPPORTS
9.1 - LIGHTING

What to Rate

Rate the lighting on a per span basis, whether the element is above or below the deck. Rate the lighting standards (base mount and pole, if present), lighting supports, bulb housing, lens, and wiring including junction boxes. Rate all types of lighting, including roadway lighting, sign lights, traffic control, navigation and aerial obstruction. Do not rate lighting attached to overhead sign structures as this responsibility rests with the Overhead Sign Structure Inspector. Lighting located on the approaches should be rated with the first or last span of the bridge if the lighting is close enough to the bridge to be considered bridge related lighting.

If several types of lighting are present on a given span, rate the condition of the worst system.

What to Look For

Check for collision damage, vandalism, and wind damage. Check structural integrity of standards and their anchorages. Check for spalls and cracking of concrete standards especially in the splash zone. For metal (steel or aluminum) standards, look for wind-induced fatigue cracks, especially at bases and welded joints. Wood standards should be checked for rot and insect damage, especially at the bases.

Check for missing or inoperable units. Most inspections are done in daylight, so it may be difficult to determine if the lighting is functioning properly. Look for obvious signs, such as a fixture hanging out of its housing, and exposed wiring. Aerial lights for aircraft are continuously lit. Navigation lights for ships are either continuously lit or have a photoelectric cell that turns the lights off during the day to conserve power. To test lights with a photoelectric cell, cover the cell for about one minute and check to see if the lights turn on. Navigation lights may be shut off during the non-navigation season.

Rating Examples

7 - New or near new condition. All fixtures appear to function properly.

5 - Minor collision damage, but not to the extent where structural integrity of the system is reduced. Some roadway lights may not be functioning. The standards may show minor deterioration.

3 - Collision damage that has reduced structural integrity of a standard or overhead frame. Any inoperable navigation, traffic control or aerial obstruction lights. Inclined poles. Any minor (non-propagating) cracks in metal standard bases or welds.

1 - Any exposed wiring or other electrical shock potential. All traffic, navigation, or aerial obstruction lights inoperative. Any fixtures hanging out of its housing. Any cracks in welds or bases, loose anchorages, or deterioration that threatens the structural integrity of the system.
9.2 - SIGN STRUCTURES

What to Rate

Rate effectiveness of bridge-related signs and structural condition of sign supports on a per-span basis. Some of the potential bridge-related signs include load postings, "R" postings, navigation markers, height restrictions, width restrictions (e.g. one lane bridge), and horizontal clearance markers. Signs on an approach should be rated with the span adjoining the approach. Signs on the under roadway are limited to bridge related signs such as clearance markers. Bridge Inspectors are responsible for all inspection aspects of signs attached to the fascias, abutments, etc of a bridge (signage is for the under roadway). The Inspector’s responsibility for overhead signage (signage is for the over roadway) is to inspect connection to the bridge including base plates of the posts. Additionally the remaining portions of the sign should be inspected as practical without the use of special inspection equipment. The remaining responsibility for the overhead sign rests with the Overhead Sign Structure Inspector.

What to Look For

Check for missing signs. Look for damaged supports or loss of legibility due to collisions, vandalism, deterioration, or other causes. Check for loose anchorages on the bridge and loss of foundation material around sign posts on the approaches. Check bridge related load posting signs for conformance with the FHWA Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) and the 17 NYCRR Chapter V (New York State Supplement to the MUTCD).

Rating Examples

7 - Signs are new or nearly new. No loss of legibility or damage of any kind.

5 - There may be minor loss of legibility due to dulled paint or loss of reflectorization. Graffiti, vandalism, or collision damage, but not affecting legibility. Minor deterioration or impact to supports.

3 - Signs are difficult to read for any reason. There may be considerable deterioration or impact damage to the supports. Any impact damage to an overhead sign base. Sign is installed improperly or is otherwise nonfunctional (for example, a horizontal clearance marker with the direction of striping reversed).

1 - Signs are illegible or missing, especially load-posting signs. Any under roadway sign or overhead sign base with collision damage or deterioration serious enough to threaten collapse. Any missing horizontal clearance markers.
9.3 - UTILITIES AND UTILITIES SUPPORTS

What To Rate

Rate the condition of the utilities on a per-span basis, including pipes, ducts, conduits, wires, junction boxes, expansion joints, couplings, valves, vents, pipe insulation, etc. Rate the supports and bracing. Include the condition of paint on utilities and their supports. If there are several utilities on the span, rate the worst utility.

If more than one utility is rated 4 or less, document the condition of each deficient utility.

Rate embedded utilities based upon observed condition. If condition cannot be observed, rate 9.

EXCEPTIONS: Electric wiring or junction boxes for bridge lighting are rated with lighting standards and fixtures.

What to Look For

Inspect for breaks, cracks, expansion joint problems, and rust on pipes and ducts. Breaks and expansion problems are more likely when the substructure has settled. Check for leaks of any kind. Gas leaks are especially dangerous. Water or sewage leaks are especially serious if leakage is onto traffic or structural components. Look for loose coverings. Flaking insulation is a serious problem and may be compounded by the presence of asbestos. If the utility hangs below the beams, vertical clearance may be reduced. This is a deficiency that could be a serious hazard and indicator of broken supports. Check vents and drains on encasement of pressure pipes. Do they appear functional?

For electric utilities that are not used for bridge lighting, check for loose wires or poor insulation. Missing covers or moisture problems are usually serious because of increased shock potential. Inspect the supports for corrosion, loose connections, or lack of rigidity. Check for collision damage to the supports.

Rating Examples

7 - New or near new condition.

5 - Minor corrosion with no appreciable section loss or loss of wrapping. Distortion or deterioration of one or two non-adjacent supports, but there is no sagging. No leaks.

3 - Heavy corrosion with noticeable section loss. Expansion joints may be nonfunctional. There may be several supports not intact causing sagging. Leaks in water or sewage lines.

1 - Flaking asbestos, major leaks or breaks. Any exposed live electric wires or other shock potential. Support failure resulting in serious distress to the utility. Major corrosion, impact damage, or severe sagging. Any gas leak.
CHAPTER 10

GENERAL RECOMMENDATION

This rating is the team leader's assessment of the bridge condition overall. Stream channel, approaches and utilities are not considered. Give maximum weight to elements of most importance, such as primary members, abutment stems, piers, scour, etc. Elements of less importance have less influence in determining the General Recommendation. The General Recommendation should not be lower than the lowest of the individually rated elements.

A General Recommendation must be provided for every general bridge inspection (see Chapter 1.1). Leave the General Recommendation blank for all other inspection types. Ratings of 8 (not applicable) and 9 (unknown) are never acceptable for the General Recommendation.

Use the following narrative descriptions as a guide for the General Recommendation:

7 - The bridge is in new condition, without deterioration except perhaps minor flaking of the top coat of paint. No work is needed other than routine maintenance.

6 - Only minor deterioration is present. Touch-up painting may be required or other minor repairs to secondary elements. Minor bearing readjustments may be needed. There may be minor cracks or spalls in the substructures.

5 - Primary members and substructures are in good condition and do not need major repairs. Bridge load capacity is not reduced, but other parts of the bridge (such as deck elements) may need extensive repairs. The bridge may require repainting because of corrosion starting on steel members. Scour may have exposed, but not undermined footings.

4 - Moderate deterioration of primaries, secondaries, and substructures has occurred, but bridge load capacity is not substantially reduced. Considerable reconditioning of secondary members, substructures, and other components may be needed. Primary members do not yet need extensive reconditioning. There may be some minor substructure undermining.

3 - Considerable deterioration of some or all bridge components. The bridge may no longer be able to support original design loads. Load posting may be needed. There may be considerable section loss on primary and secondary members. Concrete components are spalled with rebar exposure over a large portion of the areas. Extensive footing undermining may have occurred.

2 - Most bridge components are in poor condition. Primary and secondary members are extensively deteriorated. The bridge can no longer safely carry original design loads. The bridge may still be open to traffic, but at a reduced load posting. Temporary shoring or bracing may be necessary. Substructures may be so badly deteriorated to require immediate repairs. Scour and undermining may be extensive enough to threaten the stability of the bridge.
1 - Deterioration is so extensive that partial or total collapse is imminent. There is little or no live load capacity and the bridge may be closed. For the bridge to remain open to traffic, substantially reduced load posting and temporary shoring are necessary. Substructures may have settled, and be in danger of failing due to extensive undermining.
CHAPTER 11
QUALITY CONTROL & QUALITY ASSURANCE

This chapter includes the following sections:

11.1 - QUALITY CONTROL
11.2 - QUALITY ASSURANCE
11.3 - FIELD REVIEWS

11.1 - Quality Control

INTRODUCTION

Quality control is a detailed process that includes field reviews and careful examination of all parts of the bridge inspection documentation. Quality control is accomplished mainly by checking all field reports for completeness, accuracy and conformance with this manual, and by reviewing the contents of the BIN folder. This effort is augmented by field visits where the actual inspection work is observed. The person responsible is the Quality Control Engineer (QCE), whom must review all inspection reports and certify that quality control has been done. An inspection report is not official until it is certified by the QCE and accepted by the Quality Assurance Engineer (QAE). The QCE is required to complete a field review checklist (see Chapter 11.3 below) for each inspection team at least once per year. The completed field review checklists should be submitted to Regional and Consultant Project Managers and the Main Office Quality Assurance Engineer.

Checking for completeness involves thorough review of BIN folder contents to ensure that all required items are in the folder (see Chapter 2). Also, the QCE must make sure that all required documents are present and completed properly. Using the following quality control guidelines makes this easier.

Checking for accuracy and conformance with this manual requires the QCE to review the reports to make sure that all components of the bridge were properly rated and documented. The photos and comments must be consistent with the ratings given and all elements requiring an increased level of intensity should be identified as so inspected. For example, if photos and descriptions indicate that a 2 rating is appropriate, but the element is rated 5, there is a problem needing resolution. Similarly, the QCE must ensure that a statement is placed in the inspection report confirming that a 100% hands-on inspection was completed when necessary (see Appendix C for additional guidance). The QCE should discuss any apparent problems regarding report accuracy with the team leader.

GUIDELINES

The QCE shall ensure the inspection report is complete, thorough and accurate to the limit of available resources. The QCE is encouraged to use the following rules and checks for reviewing bridge inspection reports.
SUMMARY OF RULES ON PHOTOS AND COMMENTS:

- Comments and photos are required for each element rated 4 or lower.
- Comments and photos are required for any element that is uprated since the previous inspection.
- Comments are required for all elements rated 9 except footings and piles.
- Comments are required for any element rated 8 that is not normally rated 8.
- Comments are required if newly acquired record plans indicate a previous 8 or 9 rating was not appropriate.
- Comments need to be provided for any of the following kinds of rating changes:
  - from 8 to 1-7
  - from 1-7 to 8
  - from 9 to 8
  - from 8 to 9
  - from 9 to 1-7

CHECKS:

[ ] Flags – Check to see if flag documentation and actions are consistent with the previous and current flag status.

[ ] Date –
  - Should be the same as the last day in the field (see Chapter 3.2 for additional guidance).
  - For new bridges, reconstructed bridges or major rehabs, is the inspection completed within 60 days of reopening to traffic of the newly constructed bridge or any portion thereof.

[ ] Insp. Agency – Is this coded correctly?

[ ] Type of Inspection – Is this coded correctly?

[ ] Posting –
  - Are vertical clearances on and/or under the bridge coded correctly?
  - Is the load posting coded correctly?

[ ] Gen. Rec. – Is the number appropriate for the ratings and comments in the inspection report?

[ ] Access – Is the actual access used to inspect the bridge noted on the form? Are they applicable or in need of update?

[ ] Direction of Orientation – Did the inspector adhere to the established direction of orientation when providing ratings and comments?

[ ] Ratings = 9 (unknown) – Is a comment provided for every element (except footings and piles) that is rated 9?

[ ] Ratings ≤ 4 – Are condition ratings of 4 or less documented with a comment and photo(s)?

[ ] Ensure photos, ratings and comments are consistent with each other and BIM rating guidance.
[ ] Diving – Does scour documentation indicate water depths of 6 feet or more at any substructure indicating the need for a diving inspection?

[ ] Diving – Did inspector properly reference previous diving report in the bridge inspection report, where applicable?

[ ] Special Emphasis –
  • Does the special emphasis section in the BIN folder indicate non-redundant, fracture-critical, pins and hangers, fatigue-prone details, etc?
  • Have new details been introduced on the structure which are considered special emphasis details?
  • Is there an identifying sticker on the BIN folder cover?
  • Were bridges marked for special emphasis inspection, inspected and documented in sufficient detail in the inspection report?

[ ] 100% Hands-On –
  • Is this noted as being completed for fracture-critical members and/or special emphasis details (see Appendix C for additional guidance)?
  • Is the 100% hands-on inspection completed/waived for weld categories D, E, and/or E’ welds? If so, is the correct cycle being maintained for 100% hands on inspection of the details?

[ ] Field Notes –
  • Is the recorded date consistent with that recorded elsewhere?
  • Are the date, arrival, departure, temperature and weather blanks completed?

[ ] BIN Plate –
  • Where is it located?
  • Notify the Regional Bridge Maintenance Engineer of missing or defaced BIN plates for eventual replacement. (Consultant inspection teams are equipped to replace BIN plates)

[ ] Last Span Pier = 8 – Are all pier elements rated 8 for single-span bridges and for the last span of multi-span bridges?

[ ] Last Span Joint = 8 – Is the superstructure joint for a single span bridge, or for the last span of a multi-span bridge rated 8?

[ ] Are all cross references correct?

[ ] Are the proper bridge components included and rated?

[ ] Is the "Recommend Further Investigation" section completed, if necessary?
DOCUMENTATION

[ ] Forms – Were all applicable and necessary forms completed? HVA, Steel Collision Vulnerability, Debris, Overhead Electrical Survey, etc.

[ ] Names – Do all documentation forms have TL and/or ATL names and other identifying information such as date and features?

[ ] Referenced by Report – Are inspection report comments cross-referenced with all relevant documentation?

[ ] Droplines –
  • Were dropline readings taken for bridges over water? See Introduction in Chapter 4, Section B for frequency and location requirements. If not, is there a valid reason provided as to why not?
  • Does this documentation include flow depth, estimated flood flow depth, and flow direction?

[ ] Scour –
  • Are channel profiles near substructures taken if water depth and/or turbidity prohibit a visual inspection?
  • Is the extent of scour documented by sketches?
  • Are substructure deficiency (underwater) sketches done, if necessary?
  • If there are any stream channel alignment problems, is there a stream alignment sketch?
  • Is water depth measured and documented to determine if diving is required?

PHOTOS

[ ] Standard Photos –
  • Required for new bridges, after major rehabilitation or applicable change conditions noted.
  • Are all standard photos up to date regarding bridge configuration?
  • Were standard photos 6 years or older replaced?
    (See Chapter 2.5.4 for additional guidance)

[ ] North Arrow – Is the north arrow on the photo location sketch consistent with the direction of orientation?

[ ] Flow – Is the stream flow direction shown on the photo location sketch for bridges over water?

[ ] Photo Number & Location –
  • Are all photos located in the photo location sketch?
  • Are photo locations shown on the photo location sketch reasonably accurate?
  • Are above-deck photos identified as solid circles and below-deck photos as dashed circles?

[ ] References – Do all photo descriptions agree with the photo shown and actual ratings and comments?
INVENTORY

[ ] Was the inventory verified by the preparer and reviewer?

[ ] Clearances (R.R.)
  - Were vertical clearances measured, if the bridge crosses a railroad? Is the minimum clearance and its location noted? See Chapter 3.4 for requirements.

[ ] Clearances (Hwy.) – Were vertical clearances measured if the bridge crosses a highway?

[ ] Debris Form – Was it completed if required?

[ ] Access Form – Was the form completed if there was a change from the previous access requirements?

[ ] Electric Proximity – If required, was the Overhead Electric Survey form completed?

LOAD RATING

[ ] Match Plans –
  - Were structural changes to the primary members as shown on the plans or sketches-in-lieu of plans reflected in the Level II load rating?
  - Were any changes in the condition of the primary members reflected in the Level II load rating?
  - Were additional overlay thickness and railing changes (concrete parapet & steel railing) noted on the Level II load rating

[ ] Check results of the most recent Level I, if available, or Level II load rating. If inconsistent with load posting (if any), has the inspector appropriately flagged the problem?

PLANS

[ ] Plans –
  - Were record plans or sketches-in-lieu of plans reviewed by the Team Leader?
  - Were the plans initialed and dated by the Team Leader?
  - Were the plans updated to reflect comments in the inspection reports? (e.g., new wearing surface, railing replacement, bridge widening)

BIN FOLDER

[ ] Are all appropriate stickers on the BIN folder, such as 100% hands-on, electric safety and/or complex bridge?

[ ] Special Emphasis – Are areas requiring 100% hands-on inspection clearly identified in a specially prepared section at the end of the bridge report binder.

[ ] Check recent correspondences. Does the inspection report show any inconsistency with the information in the BIN folder? In particular, check posting, flags, impact damage and repairs.
SPECIAL EMPHASIS SECTION

[ ] Welds Located – Were D, E, and E' category welds located on sketches in the Special Emphasis section of the binder?

[ ] Category – Were all D, E, and E' welds properly identified?

[ ] Fatigue Analysis – This must be done for all category D, E and E' welds to exempt the 100% hands-on requirement.

[ ] NR-FCM Drawn – Does the Special Emphasis section have sketches identifying all non-redundant and fracture-critical members/details.

[ ] Did the inspector indicate within the report that the special emphasis inspection was performed? If not, was a reason provided as to why?

11.2 - Quality Assurance

Bridge inspection quality assurance is the responsibility of the Main Office, Office of Structures, Bridge Inspection Unit staff. The goals of quality assurance are:

- Ensure compliance with the UCBI. This involves verifying that all bridges due for inspection are inspected and submitted within the prescribed time limits.
- Verification of inspectors’ credentials.
- Ensure that the Flagging Procedure is being correctly implemented.
- Verify compliance with bridge inspection policy and procedures described in the Bridge Inspection Manual (BIM) and Technical Advisories (T.A.’s). This is done by reviewing BIN folders and bridge inspection reports as well as performing field reviews of the inspection teams.
- Provide continuous interpretation, evaluation and updating of policy, procedures, and standards.
- Provide instruction on the NYS bridge inspection system individually as needed and to the bridge inspection community through the NYSDOT Bridge Inspection Workshop and Annual Bridge Inspectors Meeting.
- Ensure that bridges are inspected and conditions reported uniformly statewide.

The bridge inspections Quality Assurance Engineers perform the technical QA review. This may include a detailed review of sample BIN folders. All rated elements, comments, photos, sketches, flag reports, etc. are carefully checked for technical accuracy and compliance with this manual. This review may be as detailed as the quality control review. Additionally, the QAE should review:

[ ] Who inspected the bridge? Are they approved for bridge inspection work?

[ ] If abutment, wingwall, stream channel or pier scour are rated 9, is diving recommended? If so, bring to the diving QAE’s attention for possible addition to the diving schedule.
Other inspection reports are sampled and given a less detailed review that focuses on the more important elements’ rating and documentation. Inspection reports not otherwise reviewed in more detail may be scanned briefly for obvious technical errors or omissions. The scope of the review by the QAE is discretionary based on several factors such as the level of experience of the inspection team and QC Engineer, and the past performance of the inspection group.

If there appears to be a serious problem with the use of the rating scale, if the report is incomplete, or there is some other significant technical problem, the QAE may reject the report and require resubmission. For minor problems, the report may be accepted, but comments provided so that the QCE can take steps to correct the problem for future inspections. If the Team Leader and/or the Quality Control Engineer disagree with the comments, they should contact the QAE to resolve any differences.

The technical review is documented by maintaining a database file that records, at a minimum, the submission number and date received, the number of bridges submitted, and number of bridges rejected during QA review.

Primary QA approval or failure of inspection reports should generally be completed within 30 days of receipt from the QC.

The QAE will also perform field reviews as part of quality assurance. These field review reports are maintained in the Bridge Inspection Unit's project files. A copy of the reports is sent to the Region (and Consultant).

**FLAG REVIEW**

Copies of flag reports are sent to the Main Office, Office of Structures. They are reviewed for compliance with the flagging procedure. Since flags are reviewed by the QC engineer, the review by Main Office staff should be at a level consistent with other QA efforts. The following should be checked:

[ ] - Check the flag report for omissions.

[ ] - Check technical appropriateness. Does the description and photo support the type of flag?

[ ] - Was the flag reported to the Region within the required time?
11.3 - Field Reviews

The focus of field reviews is to ensure that the inspector is thoroughly familiar with the policies and procedures governing bridge inspection, that the team is composed of personnel who are suitable for their tasks, and that the inspections are being performed efficiently and safely. Office quality control/assurance reviews of bridge inspection reports are inherently limited in their value because the end product rather than the process is examined. For this reason, field reviews of bridge inspections in progress are an essential component of quality control/assurance. The field reviews allow for a more thorough review of the inspection team's knowledge, abilities and thoroughness. The first priority is generally given to inspectors new to bridge inspection.

Field reviews should be done when the teams are inspecting bridges that are sufficiently large or complex and have some problems, to adequately judge the ability and knowledge of the teams.

Field reviews are part of both quality control and quality assurance. The QCE shall visit each new team in the field within six weeks of the new assignment. Subsequent visits by the QCE should be at approximately six month intervals. More frequent visits may be necessary if there are problems. Other field reviews may be done by Regional project managers, Regional Structures Management Engineers, Regional Bridge Evaluation Engineers, Main Office Bridge Inspection QAEs and the Federal Highway Administration.

Field reviews may be scheduled or unscheduled. In most cases, members of the inspection team should not be given any prior knowledge of the review. Therefore, Team Leaders are required to keep their QCE informed of the team's current location and proposed schedule. The time needed to observe the team doing inspections depends on the experience of the team and the type of bridge inspected. Any observed problem with the work should be documented on the field review checklist, even if the problem is not specifically covered in the checklist.

Safety is the most important element in New York's bridge inspection program. With this in mind, field reviews shall include a review of the team's compliance with all applicable state and federal safety regulations. This is also a good time to discuss current safety issues and overall safety awareness with the team.

The following Safety Field Review Checklist is provided as guidance for all field reviews:
### SAFETY FIELD REVIEW CHECKLIST

<table>
<thead>
<tr>
<th>Field Review Date:</th>
<th>BIN:</th>
<th>No. of Spans/Bridge Type:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region:</td>
<td>County:</td>
<td>Firm:</td>
</tr>
<tr>
<td>Carried:</td>
<td>Crossed:</td>
<td>Assistant Team Leader:</td>
</tr>
<tr>
<td>Team Leader:</td>
<td>QC Engineer:</td>
<td></td>
</tr>
<tr>
<td>Other Team Member(s):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following items were discussed with the inspection team during this field visit:

- Review of previous inspection report prior to present inspection to determine problem areas?
- Check BIN folder special emphasis section & bridge plans for areas requiring special attention.
- Structural behavior and primary load paths of bridge.
- Identification of D and E welds. FCMs and proper documentation.
- 100% hands-on inspection of non-redundant members.
- Proper determination & use of Direction of Orientation.
- Load restriction and vertical clearance postings.
- Use/Availability of proper access equipment.
- Proper use of safety equipment & procedures.
- Presence and use of basic inspection manuals *(checklist on page 3)*, equipment, and forms.
- Section loss measurement (D-meter, caliper, estimated, other) and documented.
- Awareness & use of the "Rating the Worst of" list with proper documentation of all elements.
- Proper use of condition rating scales.
- Appropriate use of sketches and tables when preparing documentation.
- Channel cross-section & substructure profile measurement and documentation.
- Primary completion of inspection report in the field.
- Proper photo documentation & cross referencing.
- Verification of plans or preparation of sketches in lieu of plans.
- Maintenance of Bridge Inspection Diary
- Deployment of resources and progress of inspections.
- Understanding & implementation of flagging procedures.

**REVIEWERS:**

**GENERAL REMARKS:**
## SAFETY FIELD REVIEW CHECKLIST

### Equipment

<table>
<thead>
<tr>
<th>Condition</th>
<th>Y or N</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the required PPE available?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the appropriate Personal Protective Equipment (PPE) being used?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a First Aid Kit available?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the team have a list of emergency phone numbers and locations available?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*"No" requires a comment*

### Work Zone Protection

<table>
<thead>
<tr>
<th>Condition</th>
<th>Y or N</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are cones and signs being utilized?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is Work Zone Traffic Control being used?</td>
<td>by contractor</td>
<td>by state forces</td>
</tr>
<tr>
<td>Check type used:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrow board,</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Shadow Vehicle(van)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shadow Vehicle(truck)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Impact Attenuator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flaggers (highway or railroad)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Reason for use:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the set-up in conformance with MUTCD Standards?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*"No" requires a comment*

### Access & Fall Protection

<table>
<thead>
<tr>
<th>Condition</th>
<th>Y or N</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are the inspection crew members trained in fall protection and scaffolding safety?</td>
<td></td>
<td>By Whom?</td>
</tr>
<tr>
<td>Who hasn’t been trained?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If a State UBIU is being used, are the operators certified?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is an aerial lift device being used?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If an aerial lift device is being used, have the operators been instructed in its use?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*By Whom?*
## SAFETY FIELD REVIEW CHECKLIST

### Indicate Access Type Used:

<table>
<thead>
<tr>
<th>ft - UBIU</th>
<th>ft - Lift</th>
<th>ft - Bucket Truck</th>
<th>Other</th>
</tr>
</thead>
</table>

### Questionnaire [Note: “YES” requires a comment]

<table>
<thead>
<tr>
<th>Question</th>
<th>Y or N</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the bridge being rigged?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If yes, are all safety procedures being followed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If yes, are they riggers knowledgeable in all applicable OSHA regulations?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check type used:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable and Catenary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pick with Trolley Rail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hook and Chain/Wire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other(describe)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What type of fall protection equipment is being used?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question</th>
<th>Y or N</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the inspection team feel additional safety equipment is needed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the inspection team feel additional safety training is needed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the reviewer feel additional equipment and/or safety training is needed?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### General comments:

### Personal Protective Equipment in Use

- Hard Hat
- Boots
- Respirator
- Lanyard
- High Visibility Apparel
- Protective eyewear
- Harness
- Gloves

### Required Manuals Available

- NYSDOT Bridge Inspection Manual
- NYSDOT Bridge Inspection Safety Manual
- NYSDOT Bridge Inventory Manual
- AASHTO The Manual for Bridge Evaluation
- FHWA Bridge Inspector’s Reference Manual
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Appendix A

UNIFORM CODE OF BRIDGE INSPECTION
Note: The current edition of the AASHTO Manual for Maintenance Inspection of Bridges is the AAHSTO Manual for Bridge Evaluation.

PART 165
UNIFORM CODE OF BRIDGE INSPECTION
(Statutory Authority: Highway Law §§230, 231, 233)

Section 165.1 Purpose and Authority
165.2 Applicability
165.3 Definitions
165.4 Inspection Type and Frequency
165.5 Qualifications and Responsibilities of Bridge Inspectors
165.6 Scope and Documentation of Inspections
165.7 Filing Requirements for Bridge Inspection Reports
165.8 Load Capacity Evaluation
165.9 Load Posting
165.10 Structural Integrity and Safety Rating System
165.11 Structural Integrity Evaluation
165.12 Department Authorization to Close Bridge
165.13 Filing of Bridge Design and Maintenance Guidelines

165.1 Purpose and Authority
In order to serve, protect and preserve the health, safety and welfare of the public, Chapter 781 of the Laws of 1988 established a program of comprehensive bridge management and inspection within the Department of Transportation to facilitate comprehensive bridge management, inspection, maintenance, improved knowledge of the condition of bridges, structured comparisons of bridge conditions, prioritized and optimized rankings of bridges in need of major maintenance, rehabilitation and replacement, a mechanism for improving historical predictions, the development of a means to assess and project bridge performance and deterioration, development of data to quantify the effectiveness of preventive maintenance, and increased scheduling of bridge maintenance.

Pursuant to Chapter 781 of the Laws of 1988, the Commissioner of Transportation hereby establishes a Uniform Code of Bridge Inspection which prescribes the standards for bridge inspections and evaluations; requirements for the establishment of a rating system; procedures for underwater inspections; requirements for the performance of bridge structural and foundation system evaluations in conjunction with an inspection and criteria for their need and frequency; and the qualifications of bridge design, construction, and inspection experience for licensed professional engineers who may perform or supervise bridge inspections and evaluations in accordance with the provisions of this Part.

165.2 Applicability
The Uniform Code of Bridge Inspection shall apply to all bridges which are publicly-owned, operated or maintained as defined in Section 230 of the Highway Law, which carry public highway traffic and shall not apply to bridges that exclusively carry railroad or subway tracks. This Code shall also apply to bridges which are owned, operated or maintained by railroads and carry public highway traffic over the railroad.
165.3 Definitions
As used in this Part, unless the context otherwise requires, the following words and terms shall have the following meaning:

a) "AASHTO" shall mean the American Association of State Highway and Transportation Officials.

b) "AASHTO Manual" shall mean the current edition of the "Manual for Maintenance Inspection of Bridges", and all interim updates published by the American Association of State Highway and Transportation Officials.

c) "Bridge" shall mean a structure including supports erected over a depression or an obstruction such as water, highway, or railway, having a track or passageway for carrying public highway traffic and having an opening measured along the center of the roadway of more than twenty feet between under copings of abutments or spring lines or arches, or extreme ends of openings for multiple boxes and may include multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening. The term bridge, as defined in this Part, shall also include the approach spans.

d) "Bridge Inspection Manual" shall mean the Bridge Inspection Manual published by the Department.

e) "Bridge Inventory and Inspection System" shall mean the inventory and inspection system for bridges maintained by the Department.

f) "Code" shall mean the Uniform Code of Bridge Inspection, as set forth in this Part.

g) "Commissioner" shall mean the Commissioner of Transportation of the State of New York.

h) "Department" shall mean the Department of Transportation of the State of New York.

i) "Inspection Flagging Procedure for Bridges" shall mean the engineering instruction of the same name published by the Department.

j) "OSHA" shall mean the Federal Occupational Safety and Health Administration.

k) "Public Entity" shall mean any department, board, bureau, commission or agency of the state or its political subdivisions, public benefit corporation or any public authority, including the Port Authority of New York and New Jersey.

l) "Publicly-Owned, operated or maintained" shall mean a bridge that is owned, operated or maintained by any public entity.

m) "Quality Control Engineer" shall mean the professional engineer responsible for reviewing and signing inspection reports. In signing the inspection reports, the Quality Control Engineer is attesting to the accuracy and correctness of the report in accordance with the established standards. The Quality Control Engineer shall not be the same individual responsible for performing the inspection or initially preparing the report.
n) "**Redundancy**" refers to the bridge's ability to retain structural capacity, stability and serviceability if one or more primary load carrying components or primary structural members were to structurally fail.

o) "**Substantial Structural Alteration**" shall mean any work that modifies the live load capacity, load distribution or load paths or structural behavior of the bridge.

165.4 **Inspection Type and Frequency.**

Bridge inspections shall fall into one or more of the following categories:

a. General Inspection
   b. Diving Inspection
   c. In Depth Inspection
   d. Special Inspection

a) **General Inspection.** A general inspection is the regularly scheduled inspection which each bridge receives throughout its life and which focuses on bridge condition, ability to function, safety and maintenance issues, and produces the basic statistical data necessary to understand, study, monitor and manage all bridges subject to this Code. Where applicable, a general inspection shall be scheduled during periods of low water in order to minimize the need for a diving inspection.

There are two (2) types of general inspections, "biennial inspections" and "interim inspections," as follows:

1) **Biennial Inspections.** All bridges subject to the provisions of the Code shall receive a biennial inspection which is to be performed at least once every two years. In addition:

   i. All bridges open to highway traffic while undergoing repair, reconstruction or rehabilitation shall continue to receive biennial inspections during such construction when due.

   ii. All new bridges, reconstructed bridges, and rehabilitated bridges shall receive a biennial inspection within 60 days of formal project acceptance or fully opening the bridge to highway traffic, whichever occurs first.

2) **Interim Inspections.** All bridges subject to the provisions of the Code which meet one or more of the following criteria shall receive an interim inspection:

   i. All bridges which are posted for load capacity below the State unrestricted legal load limit.

   ii. All bridges which received a General Recommendation, as defined by the current Department **Bridge Inspection Manual**, of three (3) or less during their most recent general inspection;

   iii. All bridges which carry an active structural flag, as defined by the Department's Engineering Instruction entitled "Inspection Flagging Procedure for Bridges".

A.4
All bridges which received a condition rating, that is computed by the Department's Bridge Inventory and Inspection system, of three (3.00) or less from their most recent General inspection.

All bridges for which the entity with inspection responsibility determines that it is appropriate.

Interim inspections shall be performed at or near one year after each biennial inspection. Bridges open to highway traffic while undergoing repair, reconstruction or rehabilitation shall receive an interim inspection when due.

For very large or unusual structures, a program of scheduled special inspections may be substituted for interim inspections. In such cases, the inspection scope, schedule and findings must be documented and clearly demonstrate that the basis that is the cause for an interim inspection is being addressed. In no case shall such special inspections occur at an interval exceeding that required by an interim inspection.

b) Diving Inspection. A bridge subject to the provisions of the Code shall be designated as a bridge requiring diving inspection if it meets one or more of the following diving criteria:

1) A bridge with any portion of a substructure exposed to water deeper than six (6.0) feet, during periods of normal low water, shall be designated for diving inspection.

2) A bridge with any portion of a substructure exposed to water deeper than three (3.0) feet, but no deeper than six (6.0) feet, during periods of normal low water, may or may not be designated as a bridge requiring inspection by divers depending on the judgment of the responsible professional engineer in charge of diving inspection activity. In making this determination, the responsible professional engineer shall take into consideration, among other factors, structure type, materials of construction, foundation type, footing location relative to channel bottom, known or suspected problems, waterway characteristics, superstructure and substructure redundancy, etc. In making this evaluation and resulting determination, existing bridge records, including existing inspection information shall be reviewed.

3) A bridge with no portion of any substructure unit exposed to three (3.0) feet or more of water, during periods of normal low water, will normally not be designated for diving inspection.

Diving inspections may be performed as part of a general inspection, in-depth inspection, special inspection or as an independent inspection effort. When making determinations on the need for diving inspection, it must be recognized that bridges are constructed of differing structural configurations and situated in widely varying environments. This results in varying degrees of inspection difficulty, complexity, structural redundancy and structural sensitivity. Portions of the diving inspection criteria intentionally leave discretion to provide for proper bridge-by-bridge evaluation of the above and other factors in determining the need for a diving inspection.
Diving inspections shall be performed at maximum inspection intervals of sixty (60) months. However, it shall be determined, on a bridge-by-bridge basis, if a "complete" or "partial" diving inspection is needed on a more frequent basis. If it is determined that more frequent diving inspections are needed, they shall be scheduled.

c) **In-Depth Inspection.** An in-depth inspection is a comprehensive detailed inspection of an entire bridge which frequently incorporates destructive, as well as, non-destructive inspection techniques. It is more complete and more intensive than a general inspection and the results of such an inspection can be used to satisfy the Code requirements for a general inspection. In-depth inspections are performed on an "as needed" basis to assist in making bridge rehabilitation versus replacement decisions, and to assist in the development of bridge rehabilitation designs.

d) **Special Inspection.** A special inspection is a unique inspection effort targeted at special situations or conditions and may be performed to study a unique or unusual bridge feature in greater detail than would have normally occurred during a general inspection. A special inspection may also be performed to monitor the condition of a specific bridge detail or situation on a repetitive basis and shall be performed whenever the structural integrity of a bridge is or has been threatened by a storm, flood, natural phenomenon, accident or man made occurrence.

Due to the wide variability of situations and conditions requiring a special inspection, there can be no predetermined schedule or frequency interval for the performance of special inspections. Frequency intervals are determined based on the particular parameters of the different situations and conditions under consideration.

165.5 **Qualifications and Responsibilities of Bridge Inspectors.**

a) **Field Personnel:**

1) **General and In-depth Inspection.** All field work shall be performed by an inspection team consisting of at least a team leader and an assistant team leader.

The team leader shall be present at the bridge inspection site throughout the bridge inspection, shall personally inspect the bridge, supervise other inspection team member(s) to ensure that each bridge is properly inspected and shall ensure that the inspection results are properly documented. The team leader shall ensure that additional team members are appropriately qualified and trained for their required duties, such as, traffic control, debris removal, measurement or the preparation of sketches.

A Team Leader must meet both of the following minimum qualifications:

i. Be currently registered with the New York State Education Department as a Professional Engineer (P.E.). An out-of-state P.E. registration may be substituted for a New York State P.E. provided that the individual received the P.E. based upon satisfactory completion of a 16 hour written examination, has applied for P.E. registration in New York State, and the New York State Education Department has acknowledged receipt of the individual's intent to practice in
New York under subsection (b) of Section 7208 of the Education Law, and

ii. Have at least three (3) years of bridge experience in design, construction, inspection or other bridge engineering related work.

Civil Engineering experience on Department projects or programs may be substituted for all or a portion of the experience requirement in Subsection (ii) herein, if the Department determines, on the basis of the Department work, that the engineer possesses the necessary experience and skill.

An Assistant Team Leader must:

i. Possess a Bachelor of Science Degree in Civil Engineering from an Accreditation Board for Engineering and Technology (ABET) accredited program or an equivalent degree acceptable to the Department, or

ii. Possess an Associate Degree in Civil Engineering Technology or an equivalent Associate Degree determined to be acceptable by the Department, and 1½ years of bridge experience in design, construction, inspection or other bridge related work, or

iii. Have at least three (3) years of bridge experience in design, construction, inspection, or other bridge related work.

Civil Engineering experience on Department programs or projects may be substituted for all or a portion of the experience requirements in subsections (ii) and (iii) herein if the Department determines, on the basis of the Department work, that the person possesses the necessary experience and skill.

2) Diving Inspection. All field diving inspection work shall be performed by an inspection team. The size and the makeup of diving inspection teams will vary depending on field conditions and project methodology. However, a diving inspection team shall always include a team leader meeting the qualifications of a general inspection team leader, a diver, a dive tender, if necessary, and additional personnel that are necessary to complete the inspection effort in accordance with OSHA and other regulatory requirements. The team leader and the diver may be the same person, provided that person meets the qualifications of both positions.

Divers shall have at least three (3) years experience in construction diving and/or inspection diving activities in performing the same type of diving to be used for the inspection, either "scuba" or "surface supplied air".

A dive tender shall meet all current applicable medical and OSHA requirements. In addition, a dive tender shall have at least two (2) years responsible experience in construction diving and/or inspection diving activities.

3) Special Inspection. Field work for a special inspection shall be performed by an individual or an inspection team as the situation dictates. Minimum personnel
qualifications cannot be standardized because of the widely varying situations requiring special inspections. The professional engineer in charge of such an inspection shall insure that individuals assigned to a special inspection effort are appropriately qualified and trained. This determination shall consider such factors as inspection difficulty and inspection criticality.

b) **Office Personnel:**

1) **Quality Control Engineer.** The Quality Control Engineer shall review and sign as "Reviewed By" all field inspection reports and shall meet the same qualifications specified for a general inspection team leader. An individual cannot function as a Quality Control Engineer over work for which the individual was, or is, responsible.

2) **Load Rating Engineer.** The Load Rating Engineer directs, supervises and signs all structural capacity load rating calculations. The Load Rating Engineer shall meet the same qualifications specified for a general inspection team leader.

3) **Load Posting Engineer.** The Load Posting Engineer shall make and sign all load posting determinations and shall meet the same qualifications specified for a general inspection team leader.

4) **Structural Integrity Evaluation Engineer.** The Structural Integrity Evaluation Engineer shall supervise the preparation of and signs all structural integrity evaluation reports and shall meet the same qualifications specified for a general inspection team leader.

**165.6 Scope and Documentation of Inspections.**

All general, in-depth and diving bridge inspections shall include a review of the most recent inspection report, the most recent structural integrity evaluation, and, to the extent available and reasonably retrievable and consistent with engineering practice and public safety to understand the structural performance and work history of the bridge, an examination of the design, as built plans, contract documents, history of construction including any history of structural alterations, repairs, rehabilitation or maintenance.

a) **General Inspection.**

1) Biennial Inspection. A biennial bridge inspection shall be performed and documented in accordance with Department's "Bridge Inspection Manual" including current updates, revisions and technical advisories and the AASHTO Manual.

2) Interim Inspection. An interim bridge inspection shall be performed and documented in accordance with the Department’s "Bridge Inspection Manual" including current updates, revisions and technical advisories and the AASHTO Manual, subject to the following exceptions:

   i. Conditions that have not substantially changed since the previous biennial inspection do not have to be fully documented with sketches, notes and photographs. When changes have not occurred, notes indicating that no changes have occurred since the previous biennial inspection will satisfy sketch,
note and photographic documentation requirements.

ii. Conditions that have substantially changed since the previous biennial inspection either by increased deterioration, or by repair or improvement, shall be documented with sketches, notes and photographs as required for a biennial inspection.

b) **Diving Inspection.** A diving inspection shall be performed and documented in accordance with the requirements of the Department's "Bridge Diving Inspection Specifications" and "Bridge Diving Inspection Rating Criteria" including current updates, revisions and technical advisories and the AASHTO Manual.

c) **In-depth Inspection.** An in-depth inspection shall be done in accordance with the requirements of the Department's "Specification for In-depth Bridge Inspection" including current updates, revisions and technical advisories and the AASHTO Manual. However, applicability of this specification to a specific bridge or project shall be reviewed by the professional engineer responsible for the project to determine if modifications to the standard Specification are necessary. When appropriate, this professional engineer shall develop any necessary modifications in the form of an addendum to the standard Specification or shall develop a substitute specification, which shall be used for the in-depth inspection.

d) **Special Inspections.** The inspection scope and documentation required to satisfactorily inspect and document the situation under consideration shall be determined by the individual in charge of such inspection activities.

This flexibility is necessary due to the unique and variable situations being addressed by special inspections.

### 165.7 Filing Requirements for Bridge Inspection Reports.

Two copies of all bridge inspection reports shall be filed with the Department's Regional Director located in the Department's Regional Office in which the bridge is located. Reports shall be filed within the time allowed in the following table. All General and Diving inspections scheduled for a calendar year inspection cycle shall be filed no later than January 15th of the year following the inspection calendar year.

<table>
<thead>
<tr>
<th>Inspection Type</th>
<th>Number of Days after Completion of Field Work</th>
<th>Quality Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Inspection</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>Diving Inspection</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>Special Inspection</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>In-Depth Inspection</td>
<td>120</td>
<td>30</td>
</tr>
</tbody>
</table>

All reports filed shall be neat, easy to read, include original photographs or good quality photographic reproductions, and shall be signed and dated by the individual responsible for the field inspection as well as by a Quality Control Engineer.
165.8 Load Capacity Evaluation.
Each bridge which is subject to the inspection provisions of this Code, shall be rated for safe load carrying capacity. Load ratings shall be determined in accordance with the provisions of the AASHTO Manual. If it is determined by this load rating process that the maximum legal total load under State law exceeds the load equivalent to the Operating Rating Capacity Level as defined by the AASHTO Manual, the bridge must be load posted subject to Sections 233 and 234 of the Highway Law, and Sections 1621, 1640, 1650 and 1660 of the Vehicle and Traffic Law.

a) Level 1 and Level 2 Load Ratings. Level 1 and Level 2 load ratings are defined to differentiate between rating analyses of differing degree of sophistication and/or comprehensiveness, and to differentiate whether or not the rating is certified by a Licensed Professional Engineer.

1) Level 1 Load Rating: A level 1 rating refers to any fully documented analysis or capacity evaluation that is signed and certified by a Licensed Professional Engineer as being complete and correct in its computation of bridge load capacity. Generally, a Level 1 analysis shall be in conformance with the analysis assumptions and provisions of the AASHTO Manual. However, evaluation methods and/or analysis assumptions that differ from the AASHTO provisions are permitted provided that they conform to accepted structural engineering practice, and they are fully documented and certified as being correct and appropriate by the certifying Licensed Professional Engineer.

2) Level 2 Load Rating: A Level 2 load rating refers to a specific type of computerized load rating analysis produced by the Department as part of its general bridge inspection program. However, any uncertified rating analysis that substantially conforms to the provisions and assumptions of the AASHTO Manual may be referred to as a Level 2 load rating. Level 2 load ratings may be used to identify bridges that are likely to be load capacity deficient and must receive further evaluation. Level 2 ratings may be used to assign interim load restrictions to a deficient bridge until a Level I load rating can be undertaken.

The Department's Level 2 load ratings are computed using a Department owned and maintained system of computer programs whose logic substantially conforms to analysis methods and assumptions contained in the AASHTO Manual. For each type of bridge capable of being analyzed, the Level 2 programs contain some general assumptions relating to the location of critical components or cross sections to be analyzed. Although they normally appropriate and generally accurate for typical situations they may not be correct in every case. Although quality control reviews are made, the Department does not certify its level 2 ratings as being complete and fully correct in its computation of load capacity. The Department maintains computer records of its Level 2 data and analysis results, and updates this information on a periodic basis as part of its general inspection process.

b) Criteria for performing Level I Load Rating.

1) A Level 1 load rating shall be performed as part of the structural design process for all new and replacement bridges and for all rehabilitation and repair designs involving a substantial structural alteration to the bridge. The Level 1 load rating results for the new or reconstructed structure shall be summarized in a table placed on the contract
drawings which are prepared for the project.

2) A Level I load rating shall be included as part of all Structural Integrity Evaluations as defined and required by Section 165.11 of this Code.

3) A Level 1 load rating shall be performed whenever the posted load on a bridge, or full legal load if the bridge is not posted, exceeds the operating rating capacity determined by a Level 2 load rating.

c) **Documentation of Level 1 Load Ratings:**

1) **Load Rating Vehicles:** All Level 1 load ratings shall be based on both the AASHTO "HS" and "H" analysis vehicle configurations. Both the AASHTO "HS" and "H" truck loads and equivalent lane loads shall be used to determine the rating values. If the inventory rating as defined by the AASHTO manual based on the "HS" vehicle loading equals or exceeds HS-20 (36 tons), it is not necessary to compute ratings based on the "H" loading. Load ratings based on the AASHTO "Typical Legal Load Types" (Type 3, Type 3S2, Type 3-3) or any other rating vehicle configuration are not required by this Code, but may be desirable to use for individual posting evaluations.

2) **Rating Summary Sheet:** All Level 1 rating documentation shall contain a Rating Summary Sheet, which provides the inventory and operating ratings, as such terms are defined in the AASHTO manual, for the bridge. The rating summary sheet shall also tabulate the ratings for each individual span or continuous span structural unit. For bridges which have structural floor systems, the ratings of the controlling floor system components as well as the main members shall be tabulated. Individual load rating values shall be expressed in terms of the equivalent rating vehicle and tonnage as shown:

   Examples:  
   - HS-22 (39.6 tons)  
   - 11-24 (24 tons)

   The level 1 rating summary sheet shall be signed by the load rating engineer.

d) **Filing Requirements for Level I Load Ratings.** All Level 1 load ratings shall be filed with the Department. The Level 1 load ratings shall be filed by submitting two signed copies of the rating calculations and summary sheets to the Department’s Region Office in which the rated bridge is located.

165.9 **Load Posting.**

A bridge must be posted for a restricted load limit when a load rating analysis and/or posting evaluation, as required by the AASHIO Manual and this Code, indicates that a bridge does not have sufficient live load capacity to safely carry full legal traffic loads.

A safe load level for a bridge is calculated by ascertaining the limits defined by the Inventory and Operating load rating levels and using the Operating load rating as the upper limit. However, in no case shall loads be allowed on a bridge which exceeds the bridge’s operating rating capacity.

a) **Load Posting Requirements.** No bridge shall be posted for a load less than three (3) tons. In the
event that a bridge's operating rating is less than three (3) tons, the bridge must be closed to all vehicular traffic.

b) **Load Posting Signing Requirements.** Load posting signing shall be in conformance with the New York State Manual for Uniform Traffic Control Devices.

### A.12

#### 165.10 Structural Integrity and Safety Rating System.

Structural Integrity and Safety Rating refers to a systematic method for evaluating and ranking the relative structural integrity and safety of a bridge or group of bridges against structural failure and/or collapse.

A Structural Integrity and Safety Rating system shall, at a minimum, consider the following fundamental bridge vulnerability factors, where applicable:

1) **Condition:** Refers to the extent of deterioration and/or loss of ability to structurally function as was intended by its original or rehabilitated design or loss of structural safety.

2) **Load Capacity:** Refers to the ability to safely carry live loads that may be imposed upon the bridge.

3) **Redundancy:** Refers to the bridge's ability to retain structural capacity, stability and serviceability if one or more primary load carrying components or primary structural members were to structurally fail.

4) **Fracture Susceptibility:** A measure of the presence of details and/or behavioral characteristics that are prone to fracture.

5) **Hydraulic vulnerability:** Refers to the bridge's potential for failure due to its exposure to hydraulic forces, or due to erosion or scour of the foundation material.

The rating system has the capability to rank the relative structural integrity of bridges, as well as identify bridges that have any significant vulnerability with regard to any one or a number of the above-noted vulnerability factors.

Structural integrity and safety ratings shall be made for all bridges. The rating system to be used shall be either the system developed by the New York State Department of Transportation for use on its bridges or the public entity may develop a rating system unique for bridges under its jurisdiction. Any public entity that establishes a rating system for use in complying with this Code shall file with the New York State Department of Transportation a description of the rationale and/or logic of the rating method, as well as a list of integrity ratings for all bridges under their jurisdiction. Filing of rating systems and bridge structural integrity and safety ratings shall be with the New York State Department of Transportation Main Office Structures Division. Structural integrity and safety ratings shall be updated on a biennial basis to reflect any changes recorded by general inspections.

The New York State Department of Transportation shall maintain a structural integrity and safety rating system which it will apply to all bridges which it inspects. This system is to be made available to all public entities for their own use. The description and criteria of the New York State Department of
Transportation structural integrity and safety ratings are issued as a reference document to this Code, and is titled "New York State Department of Transportation Structural Integrity and Safety Rating Guide." This document also contains criteria, based on a structural integrity and safety rating system, for requiring a Structural Integrity Evaluation as described in Section 165.11 of this Code.

165.11 Structural Integrity Evaluation.
A Structural Integrity Evaluation is a detailed structural and foundation evaluation and analysis. Used in conjunction with an inspection, it details a bridge's structural condition and integrity as well as present and future needs to preserve or upgrade the safety and serviceability of the bridge.

The scope of a Structural Integrity Evaluation shall include, where applicable to the determination of integrity and safety, the following:

a) A review, where available and reasonably retrievable and consistent with engineering practice to perform such an evaluation, of the design, design as-built plans, contract documents, and history of construction, structural alterations, rehabilitation, and maintenance repairs.

b) A review of design Code changes since the time of original design with emphasis on the impact the original design assumptions have on the bridge's structural integrity and safety in comparison with current standards and practices.

c) A Level 1 Load Rating as defined by Section 165.8 of this Code.

d) For bridges over water, an evaluation of the effect of relevant or anticipated stream changes, as well as an evaluation of the effects of hydraulic flows, including design flood conditions. The Federal Technical Advisory (Code T 5140.20) titled "Scour at Bridges" published by the Federal Highway Administration may serve as a guide for evaluating bridges for scour vulnerability.

e) An evaluation of the effects of deterioration and modification to the original structure on structural integrity, in conjunction with a general inspection conforming to the requirements of this Code.

f) A life cycle projection of the scope and estimated cost of maintenance, repair, and/or rehabilitation needed to preserve or upgrade the structural integrity and safety of the bridge, in order to provide criteria for comprehensive bridge management and safety.

Structural Integrity Evaluations shall be documented in a detailed report format and shall be signed by a qualified Structural Integrity Evaluation Engineer as defined by Section 165.5 (b)(4) of this Code. Two copies of the Structural Integrity Evaluation report shall be filed with the New York State Department of Transportation Regional office in which the bridge is located. One copy of the report shall be made available to the bridge inspector as a reference for all subsequent general bridge inspections.

Whenever a Structural Integrity and Safety Rating indicates a high vulnerability to structural failure a structural integrity evaluation shall be performed. Specific criteria for requiring a Structural Integrity Evaluation to be performed based on the New York State Department of Transportation structural integrity and safety rating system are described in the New York State Department of Transportation "Structural Integrity and Safety Rating Guide."
In cases where a bridge meets the criteria for requiring a Structural Integrity Evaluation, but already has such an evaluation on file, a repeat evaluation is not required unless it is determined that the evaluation on file is no longer appropriate for the bridge in question. A recommendation of appropriateness shall be made and documented by the Bridge Inspection Team Leader based on a review of the report as part of performing a general bridge inspection. In cases where only portions of the report are no longer appropriate, amendments to the original Structural Integrity Evaluation report may be produced.

165.12 Department Authorization to Close Bridge.
Each Department Regional Director is authorized to close any bridge subject to this Code which, if in his opinion, based upon inspection or otherwise, if not closed, may constitute a threat to the public health, safety or welfare.

When such a closure is required, the Regional Director shall document the reasons for the closure and transmit such documentation to the bridge owner. The bridge cannot be reopened to traffic without a certification of a professional engineer licensed in New York, that the bridge is safe for public use and travel with legal weights, or if posted, with such posted weights. The party having jurisdiction over the bridge is responsible for providing this certification to the Department.

165.13 Filing of Bridge Designs, and Maintenance Guidelines.

a) Every owner of a publicly owned, operated or maintained bridge, as defined in Section 165.2 of this Title, shall submit to the New York State Department of Transportation certified designs and "as built" plans for all bridges constructed or on which substantial structural alterations are made on or after June 1, 1989.

b) All designs and plans shall be certified by a licensed Professional Engineer and must bear the signature and seal or stamp of such Engineer.

c) All designs and plans shall be submitted to the Department of Transportation Regional Director within whose region such bridge is located.

d) Maintenance Guidelines. All certified designs and plans subject to this section shall contain desirable maintenance guidelines applicable to the bridge. Such guidelines shall be consistent with standards established by AASET0, and this requirement may be satisfied by the designer by reference to these standards. Designs and plans for very large or unique bridges and moveable bridges shall include special maintenance guidelines as is appropriate.
Appendix B

INSPECTION FLAGGING PROCEDURE FOR BRIDGES
INSPECTION FLAGGING PROCEDURE FOR BRIDGES

I. INTRODUCTION

This procedure sets forth a uniform method of timely notification to Responsible Parties of bridge deficiencies that require timely attention. It also establishes requirements for certifying that appropriate measures are taken within a specified time frame by a professional engineer licensed to practice in New York State.

The procedure shall only be used to report conditions posing a clear and present danger or conditions that, if left unattended, would likely become a clear and present danger before the next scheduled biennial inspection. A Flag is not used to report a structural condition of a component whose service life clearly extends well beyond that defined by scheduled inspection intervals nor used to draw attention to any maintenance or routine repair needs where no immediate or potential danger exists. The Regional Director shall close any bridge that is determined to be unsafe, at any time, regardless of the steps being followed in this procedure.

II. DEFINITIONS

FLAG TYPES:

Red Flag - A structural flag that is used to report the failure or potential failure of a primary structural component that is likely to occur before the next scheduled biennial inspection.

Yellow Flag - A structural flag that is used to report a potentially hazardous structural condition which, if left unattended could become a clear and present danger before the next scheduled biennial inspection. This flag would also be used to report the actual or imminent failure of a non-critical structural component, where such failure may reduce the reserve capacity or redundancy of the bridge, but would not result in a structural collapse.

Safety Flag - A flag that is used to report a condition presenting a clear and present danger to vehicular or pedestrian traffic, but poses no danger of structural failure or collapse. Safety Flags can be issued on closed bridges whose condition presents a threat to vehicular or pedestrian traffic underneath or in their immediate vicinity.

Flagged - General term applied to a bridge which has received a flag or to the specific condition for which a flag is issued.

Flag Documentation - This consists of the "Flagged Bridge Report" (FBR), any additional notes or sketches, photos, scour documentation (if applicable), and any other items needed to document the flagged condition.

Prompt Interim Action (PIA) - A designation that is made by the inspection Team Leader or an engineer when a Red Flag or Safety Flag condition is considered extremely serious and in need of immediate attention. This designation requires a prompt (within 24 hours) action or decision.
on whether to close or restrict loads on the bridge, make immediate repairs, or to determine that the condition is safe until repairs can be made.

Regional Bridge Engineer (RBE) - A Professional Engineer licensed to practice in New York State (NYSPE), who is responsible for ensuring that the flagging procedure is followed and monitor the status of the flags. Generally, these are the responsibilities of a Regional Bridge Management Engineer. The Regional Director is responsible for designating the RBE for his/her Region. The RBE shall not be the same person designated as the Responsible Party. References to the RBE shall also include the RBE’s designee.

Responsible Party - The party (or parties) that have maintenance responsibility for the flagged portion of the bridge. The Regional Bridge Maintenance Engineer (RBME) is considered the Responsible Party for the State bridges in their respective Region. Occasionally, a condition that causes a flag occurs in a portion of a bridge that is the maintenance responsibility of one party, but protective actions must be taken by a second party. In such cases, the RBE shall identify such situations and notify all responsible parties.

State Bridge - Any bridge either partially or wholly owned or maintained by the New York State Department of Transportation (NYSDOT).

Non-State Bridge - Any bridge that cannot be defined as a State Bridge.

FLAG STATUS:

Red Flags are categorized as follows:

Active Flag - A Red Flag for which a "Flag Removal/Inactivation Report" has not been filed. Active Red Flags shall be categorized as:

A) Response pending: Status used from flag issuance to until six weeks from the written notification to responsible party unless categorized C thru J noted below.

B) Response overdue: Status used beyond six weeks from written notification to responsible party unless categorized C thru J noted below.

Inactive Flag - A Red Flagged condition for which a "Flag Removal/Inactivation Report" has been filed indicating "Flag Inactivation." Inactive Flag categories are as follows:

C) Bridge temporarily closed or partially closed (e.g., individual lane or shoulder closure).

D) Bridge temporarily posted or down posted for reduced load, based on certification by a NYSPE.

E) Certified safe by a NYSPE in its current condition for an interim period while subject to pending/scheduled repairs; or certified safe by a NYSPE subject to a defined condition monitoring program being implemented; or temporary repairs made and certified as safe by a NYSPE.
Removed Flag - A Red Flagged condition for which a "Flag Removal/Inactivation Report" has been filed indicating "Flag Removal." Flag Removals are categorized as follows:

F) Bridge is permanently closed.
G) Bridge is certified by a NYSPE as "safe," at least until the next scheduled biennial inspection, for legal load or the currently posted load.
H) Permanent repairs have been made and certified by a NYSPE.
I) Bridge is permanently posted for load on the basis of Load Rating calculations by a NYSPE.
J) Flag has been superseded or reclassified.

Safety Flags and Yellow Flags are categorized as follows:

Active Flag - A Safety or Yellow Flag for which a "Flag Removal/Report" indicating “Flag Removal” has not been filed. For Safety and Yellow Flags, Active flags shall be categorized as:

A) Active

Inactive Flag – Safety or Yellow Flags are not categorized as inactive.

Removed Flag - A Safety or Yellow Flagged condition for which a "Flag Removal/Inactivation Report" has been filed indicating "Flag Removal". Flag Removals are categorized as:

J) Flag has been superseded or reclassified.
R) Removed

III. FLAGGING PROCEDURE

The following steps shall be taken to issue Red Flags, Yellow Flags, and Safety Flags. These steps apply to both State and non-State bridges. A copy of the Flag Documentation and all related and subsequent correspondence shall be placed in the BIN folder. This procedure is written for an Inspection Team leader to use during a bridge inspection, however, other professional engineers may issue a flag as needed by following the appropriate steps.

A. Red Flag

1. Observation - Immediately after the Flag condition is observed, the inspection Team Leader shall complete Steps 2, 3, and 4.

2. Prompt Interim Action - The inspection Team Leader shall determine if the problem warrants a designation of "Prompt Interim Action." If this designation is made, it shall be included in the verbal notification to the RBE (see Step 4 below). In an extreme case, where an actual failure or clearly perilous condition exists, the Team Leader shall take immediate measures to close the bridge and, where necessary, close the feature under the bridge prior to notifying the RBE.

3. Prepare Flagged Bridge Report (FBR) - The inspection Team Leader shall complete
the FBR (see copy attached) and shall attach photographs and other documentation as needed to adequately document the condition. If in the Team Leader's judgment, expediency is required, verbal notification (see Step 4) to the RBE may be made before completing the FBR.

4. **Verbal Notification of RBE** - The Team Leader shall immediately, upon completing the FBR, telephone the RBE describing the physical condition. The Team Leader shall record the name of the person notified and the date/time of notification on the FBR. The RBE shall determine who is the Responsible Party for the flagged portion of the bridge.

5. **Verbal Notification of Responsible Party** - The RBE shall immediately notify the Responsible Party. The RBE shall make the inspection team and necessary access equipment available at the bridge site to explain the flagged condition, if so requested by the Responsible Party.

6. **Decision on Prompt Interim Action Flags** - In case of a "Prompt Interim Action" designation, appropriate action by the Responsible Party is required to address the observed condition within 24 hours. Possible actions include:
   - Fully or partially closing the bridge.
   - Post for reduced load reflecting the current bridge condition.
   - Determine that the condition doesn't require Prompt Interim Action Designation and follow normal Red Flag procedure.
   - Specify when and what actions are needed, if less than 6 weeks.

   Any action by the Responsible Party, except fully closing a bridge or replacing a posting sign, must be certified by a NYSPE in writing to the RBE within 24 hours. Any action that is deferred beyond the 24 hours shall also be certified by a NYSPE that the bridge is safe until appropriate action can be taken. The RBE shall document the decision made on any Prompt Interim Action designation in the written confirmation to the Responsible Party.

   When the Red Flag "Prompt Interim Action" designation causes a full or partial bridge closure, posting, or change in posting, or affects traffic flow, the RBE shall immediately inform the Regional Director and the Director of the Office of Structures in the Main Office.

   At the same time, for all flags, bridge closures, postings, changes in posting information, or temporary closures should be updated in the databases and necessary personnel informed (including the Main office Bridge Data Systems Unit within three days) following the established departmental procedures. The RBE is responsible for initiating the appropriate steps to accomplish this.

7. **Flag Documentation** - The flag documentation shall be completed by the Team Leader and forwarded to the RBE within three working days from the date the flagged condition was observed.
8. **Written Notification (Flag Letter) to Bridge Owner** - The RBE shall transmit a copy of the Flag Documentation by letter or memo to the Responsible Party (see attached Sample #1.) The flag transmittal must accurately state the facts and clearly emphasize the degree of urgency involved. It shall also clearly state that the Responsible Party is solely responsible for addressing the flag condition. As an alternate to restating all the particulars of the flag condition, the transmittal memo may refer to information contained in the Flag Documentation. This written notification shall be sent within a week from the date the flagged condition was observed. The letter shall also request written acknowledgment of receipt of the flagging letter. A signed certified mail delivery receipt can be substituted for the acknowledgment.

9. **Response from Responsible Party to Written Notification** - The response shall be signed by a NYSPE, explaining what action is or will be taken and when it will be taken. If no action is being taken, the response will explain the reasons for this decision. All actions proposed or taken, except for bridge closure, must be certified by a NYSPE. Generally, all actions taken shall be completed within six weeks from the date of Written Notification to the Responsible Party, but if action is deferred, a NYSPE shall certify that the bridge is safe and the flagged condition is not a danger to the traveling public until appropriate action can be taken at a specified date. A response that the bridge has been closed or a posting sign replaced does not require a NYSPE certification.

This response is required within six weeks of the date of Written Notification to the Responsible Party. If the Responsible Party has not replied within four weeks, the RBE will verbally inform the Responsible Party of the impending deadline. A record of this verbal notification should be kept in the BIN folder. The RBE will monitor action taken on Red Flags. Follow up may include closing a bridge if the bridge owner does not take action.

10. **Flag Removal/Inactivation** - When certified corrective or protective actions are reported by the Responsible Party as completed for all deficiencies causing the Red Flag, or the bridge condition is certified as safe, the RBE shall remove or inactivate the flag. A flag is removed when the bridge is permanently closed, abandoned or removed, when the bridge is certified "safe" for legal load, when it is permanently posted for load on the basis of certified load rating, or when permanent repairs have been certified as adequate at least until the next scheduled biennial inspection by a NYSPE. A flag is made inactive when the bridge is temporarily closed or partially closed, when it is temporarily posted for a reduced load, or when temporary repairs are made and certified as safe by a NYSPE, or certified safe by a NYSPE in its current condition for an interim period while subject to pending/scheduled repairs, or certified safe by a NYSPE subject to a defined condition monitoring program being implemented. The RBE shall complete a Flag Removal/Inactivation Report to remove the flag.
from the list of active Red Flags. A copy of the report shall be sent to the Responsible Party and a copy placed in the BIN folder. If the inactivation is valid only for a limited time, responsible party shall take appropriate actions thereafter.

*Note on removal date:* Removal date shall be the date of action of responsible party (examples include: date of certification memo, date of calculation, date construction completed/certified, date structure or lane closed, etc...). It is *not* the date of Flag Removal/Inactivation report.

11. **Overdue Flag Response** - The RBE shall monitor the lists of bridges with active Red Flags for receipt of written replies from the Responsible Party. If no reply is received within five weeks of written notification of a flag, the RBE shall send a follow-up letter to the Responsible Party, with copies to the Regional Director and, for non-state bridges, to the Chief Executive Officer or Agency Head/Commissioner of the corporation or political jurisdiction which owns the bridge. This letter shall require action within the six week time limit from notification and be followed by a phone call from the RBE. If the second notification does not produce a satisfactory response within the six week time limit and if the bridge is determined to be unsafe by RBE, the Regional Director shall close the bridge. The Responsible Party shall be made aware of this policy and its implications, especially for traffic and emergency vehicles.

**B. Yellow Flag**

1. **Observation** - Immediately after the problem is observed, the inspection Team Leader shall complete the "Flagged Bridge Report" FBR (see copy attached).

2. **Flag Documentation** - The flag Documentation shall be completed by the Team Leader and forwarded to the RBE within a week from the date the flagged condition was observed.

3. **Written Notification (Flag Letter) to Responsible Party** - The RBE shall send a copy of the Flag Documentation to the Responsible Party (see attached Sample #2). The flag transmittal must accurately state the facts. If the Flag Documentation clearly covers all necessary information, the transmittal memo may be a short transmittal merely forwarding the FBR. This written notification shall be made within two weeks from the date the flagged condition was observed. The notification shall require that, upon completion of any repairs made to the flag condition, the Responsible Party submit certification by a NYSPE of the repair, including when the repairs were completed and that the condition is safe.

4. **Acknowledgment to Written Notification** - The Responsible Party shall acknowledge receipt of the Flag Documentation in writing within six weeks of
the written transmittal. A signed certified mail delivery receipt will also be accepted as acknowledgment.

5. **Flag Removal** - When corrective or protective actions are reported by the Responsible Party as complete for all deficiencies causing the Yellow Flag, the RBE shall remove the flag. The work must be certified by a NYSPE. If temporary measures are taken, the flag can be removed as long as the NYSPE certifies that the temporary measure is adequate at least until the next biennial inspection is scheduled. The RBE shall complete a Flag Removal Report to remove the flag from the list of active Yellow Flags. A copy of the report shall be sent to the Responsible Party and a copy placed in the BIN folder.

*Note on removal date:* Removal date shall be the date of action of responsible party (examples include: date of certification memo, date of calculation, date construction completed/certified, date structure or lane closed, etc...). It is **not** the date of Flag Removal/Inactivation report.

C. **Safety Flag**

Follow the same procedure for Yellow Flags with the following exceptions:

1. The Team Leader shall determine if the problem warrants a Prompt Interim Action designation and in that case, the notification procedures for Prompt Interim Action designation for "Red Flags" shall be followed.

2. If Prompt Interim Action has been designated, verbal notification of Safety Flags shall be made by the Team Leader to the RBE and by the RBE to the Responsible Party.

3. Corrective action to remove a Safety Flag does not have to be certified by a NYSPE.

4. The presence of an active Safety Flag does not require that the bridge be inspected annually.

IV. **FLAG RECLASSIFICATION**

Red Flags may be replaced by Yellow Flags and vice versa based on an evaluation by the RBE, Team Leader, and Responsible Party. The RBE has the reclassification authority. In either case, the original flag should be removed and a new flag issued with a new flag number. Documentation requirements to change a Red Flag to a Yellow Flag are the same as for flag removal. The FBR used to reclassify the flag shall be filed in the BIN folder with a copy to the Responsible Party.

A Flag Removal/Inactivation Report shall also be made for the Original Flag with the same distribution of copies. The reclassification process is intended to allow for further
analysis after the initial Flagged Bridge Report has been completed and transmitted.

V. FLAG CONTINUATION

When an existing flagged condition is found by the Team Leader to remain in a subsequent inspection, the condition shall be reflagged with a new Flagged Bridge Report with complete documentation. The new flag shall be assigned a new flag number. All other information shall be completed on the Flagged Bridge Report including the superseded flag number. The Flagged Bridge Report shall note that an existing flag is being superseded. If a Yellow Flag becomes a Red Flagged condition and vice versa, then a new flag is issued with a new number. The original Yellow Flag shall be removed in these situations.

VI. LOAD RATING FLAGS

The load rating and posting procedures for bridges are found in their respective Engineering Instructions (EI). Action shall be taken if the posting displayed on a bridge is inconsistent with the load rating information.

A. A Red Flag with a "Prompt Interim Action" designation shall be issued when the controlling "II" operating rating for a bridge is:

1. Less than 3 tons and the bridge is open to traffic; OR
2. Less than 50% of the posting on the bridge; OR
3. 15 tons or less when there is no posting on the bridge.

B. A Red Flag shall be issued when the controlling "H" operating rating for a bridge is:

1. 3 tons or more below the posting on the bridge; OR
2. 22 tons or less when there is no posting on the bridge.

C. A missing or illegible load posting sign (excluding “R” posting sign) shall be Red Flagged with "Prompt Interim Action" designation.

D. A missing or illegible "R" posting sign shall be Red Flagged.

E. A Yellow Flag shall be issued for all other cases of load rating/posting inconsistencies not covered by paragraph A thru D above. A legible posting sign with the correct posting information, but which is nonconforming in minor details, should be Yellow Flagged.

VII. SCOUR DAMAGE FLAGS

Scour damage poses a unique vulnerability to bridges. Hydraulic and scour induced damage is the leading cause of bridge failures both statewide and nationally. It is
also recognized that scour induced damage takes a significant amount of time to repair. Therefore, the Responsible Party shall be urged to schedule repairs as quickly as possible.

With the possible exception of some very small bridges, a reduction in live load has little or no effect on the capacity or stability of a bridge foundation subject to scour damage. Therefore, the down posting of a bridge will rarely be sufficient by itself to inactivate a Red Flag resulting from scour damage. If the Responsible Party has scheduled repairs, and an evaluation by a NYSPE of the integrity and safety of the bridge during the interim has been made and appropriate flood watch procedures have been adopted, then these steps can be sufficient to inactivate a Red Flag. Red Flag removal can generally only be accomplished by repair of the scour damage.

Naturally occurring scour infilling can have a dangerously deceptive appearance that scour damage no longer exists. Such a possibility must be ruled out before a scour damage flag can be removed or inactivated.

An example of a Flag Letter (see the attached Sample #4) due to scour damage is attached.

VIII. CLOSING UNSAFE BRIDGES (ALL BRIDGES)

Closure proceedings shall be initiated at any point by the RBE, even in cases where this flagging procedure is being followed, when it is evident that the measures being taken by the Responsible Party do not eliminate a clear and present danger. If a Red Flag is not removed or inactivated within six weeks by appropriate corrective or protective action, and the bridge is determined by the RBE to be unsafe, the Regional Director shall close the bridge. A bridge closed because of a flag shall not be reopened until the structure is certified as safe by a NYSPE.

IX. UNDOCUMENTED REPAIRS

If during an inspection, a Team Leader finds that undocumented repairs have been or are being made to a previously flagged condition, but the flag has not been removed, then one of the following actions shall be taken:

a. If, in the Team Leader's judgment, the repairs are adequate and complete enough to remove the flag, the Team Leader shall document the repairs and remove the flag using a Flag Removal/Inactivation Report.

b. If the Team Leader judges the repairs to be inadequate, then the condition shall be reflagged using a Flagged Bridge Report. The superseded flag shall be removed when the new flag is entered.
X. INTERIM INSPECTIONS

Interim inspections shall be scheduled for all bridges with active or inactive Red Flags or active Yellow Flags. During the inspection, if the Team Leader finds the previously flagged condition has been corrected and is no longer deserving of a flag, the Team Leader shall remove the flag. If this flag was the sole reason for the bridge requiring an Interim inspection, then the Interim inspection should be terminated. The RBE shall remove the flag from the list of active flags and file the Flag Removal/Inactivation Report in the BIN file. If the flagged condition has not been corrected, or there is a new flag condition, the Team Leader shall reflag the bridge.

For large and unusual bridges, special inspections may be substituted for interim inspections in accordance with the requirements of the Uniform Code of Bridge Inspection. If the bridge has been flagged for an isolated, localized, non-recurring condition, a special in-lieu of inspection covering inspection of the specific flagged condition can be substituted for the interim inspection. All such waivers of interim inspection shall be made by the Main Office Bridge Inspection Unit Supervisor.

XI. FLAG INVENTORY

The RBE shall maintain a current list of active and inactive Red Flags, active Yellow Flags, and active Safety Flags. The list of flags shall be classified according to "Flag Status," in Section II of this procedure, as appropriate.

The Main Office Bridge Inspection Unit also maintains an electronic database to track the status of the flags. It is the responsibility of the RBE to make sure that the information in this database for all the bridges in his/her Region is current and correct.

XII. PUBLIC AUTHORITIES

Public Authorities, responsible for their own bridge inspections, can elect to use this Flagging Procedure with appropriate modifications made to references to NYSDOT positions. Alternatively, they can develop an agency specific flagging procedure that has similar scope to assure public safety. The procedure shall be documented and shall have provisions to designate flags (similar to red, yellow, and safety), timely notification of flags, and a mechanism to ensure the flags are addressed in a timely manner.

At Regional discretion, Authorities shall immediately notify the RBE verbally of all flags that have the potential to disrupt traffic on NYSDOT or locally maintained highways. All flags issued during the bridge inspections shall be included in the inspection reports.

Any flags issued by State inspectors or consultant inspectors working for DOT that affect Authority traffic shall be reported to the Authority involved in the same manner and within the same time limits that the authorities are required to report to the Department.
XIII. ELECTRONIC COMMUNICATION

Except for the verbal notification required for PIA flags, all other verbal and written correspondence may be substituted with electronic communication such as e-mail. A mechanism should be in place to make sure that the electronic communication has been received and has been reviewed in a timely manner. The Regional Director is solely responsible to ensure that measures consistent with the flagging procedure are in place when electronic or other communication methods are adopted. RBE shall clearly document this procedure with all steps and procedures and provide a copy to RD and the Main office Bridge Inspection Unit. A printed copy of all correspondence shall be placed in the BIN folder. All e-mail correspondence should have the same information that would have been in verbal or paper correspondence.

PE certifications cannot be substituted with verbal assurances. If electronic mail is used to receive the certifications from the Responsible Party or their consultants, all e-mail should come directly from the NYSPE (not from someone in his/her staff on his/her behalf), and the e-mail should contain all the content which is required with a paper certification including NYSPE's License Number and NYSPE's mailing address. A printed copy of the e-mail should be placed in the BIN folder within two weeks after the flag has been addressed.

XIV. NYSPE LICENSE VERIFICATION

The Department periodically verifies the current registration status of the NYSPEs employed by the Department. The RBE is responsible for making sure that the non-NYSDOT certifying NYSPE has a current registration. This may be accomplished by accessing the State Education Department database that is available on-line.

XV. GUIDELINES

Flags are issued separately for each condition noted on a bridge. Each condition can have only one flag, but it is possible for a bridge to have more than one flag or to have both Yellow and Red flags or other combination of flags. Multiple occurrences of similar conditions on a bridge requiring a Red or Yellow flag may be documented and submitted, using sound engineering judgment, under one Red or Yellow flag as long as every occurrence (location and extent) is explicitly described in the flag details. It should be noted that to remove or inactivate the flag, each condition shall be addressed appropriately with NYSPE certification specifically explaining how each of these conditions were addressed.

For closed bridges, red or yellow flags should not be issued unless conditions can cause structural collapse under existing loads before the next scheduled (biennial or interim) inspection. If any of the observed conditions on a closed bridge constitute a safety hazard to traffic/users underneath, the appropriate safety flag (if necessary with PIA designation) shall be issued.
All non-NYSDOT NYSPE Certifications shall have the NYSPE’s name, license number, and mailing address.

As a quality control effort, RBE shall periodically review the Flags Documentation and discuss with Team Leaders in order to ascertain the effectiveness of the flagging procedure; and discuss these findings with the Main Office Bridge Inspection Unit and other RBEs. As a quality assurance effort, the Main Office Bridge Inspection Unit shall review selected Flags Documentation and correspondence to evaluate the effectiveness of the inspection program and initiate changes, as needed. Flags Documentation shall contain sufficient information for this review.

XVI. HYPOTHETICAL EXAMPLES

Each bridge and its condition are different due to factors such as design, materials used, loadings, and deterioration. Hence, professional judgment by competent personnel is required. The following provides hypothetical examples of conditions which might warrant various flag types. These examples are not meant to list all situations, nor be a limit guideline for determination of flag issuance, but are typical examples of conditions that have occurred in the past. In cases of deterioration (such as section loss), detailed capacity evaluations may be required and can be recommended by the Regional Bridge Engineer.

Examples that generally warrant Prompt Interim Action designation are noted below. Other listed examples may require Prompt Interim Action designation, if in the judgment of the Inspection Team Leader the condition poses an immediate threat to structural stability.

A. Red Flags

1. Substructure Examples

   a. Scour that has caused more than minor undermining of an abutment or pier without piles and is not founded on rock and the danger of failure is imminent or potentially imminent with the next flood.
   b. Movement, deterioration, or distress in piers or abutments which is so excessive that there is a clear possibility that it may fail to support the superstructure. (Prompt Interim Action)
   c. Structural cracks in substructures along with continuing signs of movement.
   d. An abutment not on piles that has a large scour hole beneath the footing and exhibits vertical or diagonal cracks in the stem.
   e. A cap beam in a two column concrete pier that has reinforcement cage exposed for its entire length on the underside with broken longitudinal reinforcing bars at the midspan.
f. Deterioration of a concrete pedestal under the bearing of two girder bridge or truss that has reduced the effective bearing area 50% or more.

g. A six or more girder bridge that has lost 50% of the bearing area in two adjacent concrete pedestals.

h. Debonding of structural Fiber Reinforce Polymer (FRP) wrap.

2. Superstructure Examples

a. Distortion in a load path non-redundant member (e.g., the visible buckling of a compression chord member in a truss).

b. Any crack in a fracture critical member or major impact damage in a primary member. (It should be noted that the primary members and fracture critical members include the connections between them).

c. Any condition causing visible change in primary member elevation or profile such as sagging and crippling. (Prompt Interim Action)

d. A one-third or greater loss of section to the top or bottom flanges of a non-redundant member (or on two or more adjacent girders of a redundant girder bridge) in an area of high flexural stresses. A one-half or greater loss of section to a non-redundant girder web (or on two or more adjacent girders of a redundant girder bridge) at or near a support or point of maximum shear.

e. Expansion bearings overextended to the point that portions of the superstructure may drop in elevation.

f. High rocker bearings that appear to be at or near to their full extension or full contraction (tilt) when ambient temperatures are not near extreme levels.

g. For steel beams and plate girders with bearing stiffeners, with more than 75% section loss and holes through the web in non-redundant member or multiple redundant members.

h. A hole in a bridge deck along with deterioration of the bridge deck extensive enough to threaten a structural failure of the deck. Normally, holes in a bridge deck will be Safety Flags.

i. A crack in the tension flange of a welded two girder bridge. (Prompt Interim Action)
Appendix B

j. Missing load posting sign. (Prompt Interim Action)

k. A truss gusset plate that has lost 50% or more of its section in a line above the connection to the bottom chord.

l. A composite prestressed concrete adjacent box beam bridge with more than 30% broken total strands in two adjacent beams near midspan.

m. A crack in the tension area or cracks in compression areas of a steel primary non-redundant member.

n. Debonding of structural Fiber Reinforce Polymer (FRP) wrap.

o. Web Bearing Areas of:

Rolled Beams without Bearing Stiffeners:
- When corroded to the point of having a hole through the lower portion of the web in the bearing area, even if distortion has not yet occurred.
- When the possibility of a localized failure of the lower portion of the web in the bearing areas exists.

Rolled Beams & Plate Girders with Bearing Stiffeners:
- When the lower portion of web in the bearing area and the bearing stiffeners have more than 75% combined section loss for non-redundant members or multiple beams with this condition in the same line of bearings.

p. A crack is found in floorbeam hangers of pin connected truss.

B. Yellow Flags

1. Substructure Examples

a. Pier or abutment piles exposed due to scour, but the piles are still capable of functioning. Number of piles exposed, length of piles exposed, and condition of piles should be used to make informed judgment.

b. A cracked and spalled pedestal with more than 50% loss of bearing on a multi girder bridge. Depending on stringer spacing, deck condition, or fascia location, this could possibly be a Red Flag.

c. A pier capbeam with half the tension reinforcement completely exposed for the entire span between columns.
2. **Superstructure Examples**

a. Two non-adjacent girders on a redundant girder bridge with a one-third or greater loss of section to the top or bottom flanges near their point of maximum bending or a one-half or greater loss of section to the girder webs near the supports or point of maximum shear.

b. A crack in the tension area or cracks in compression areas of a steel primary redundant member.

c. A fascia girder in a multi girder bridge that is bent out of alignment (not severely) with a crack in the web at a diaphragm connection.

d. A composite prestressed concrete adjacent box beam bridge that has 20 to 30% broken total strands in two adjacent beams near midspan or 40% broken total strands in a single beam.

e. Web Bearing Areas of:
   - Rolled Beams without Bearing Stiffeners:
     - When the webs have lost more than 50% of their thickness to corrosion in the lower portion of the bearing area.
   - Rolled Beams & Plate Girders with Bearing Stiffeners:
     - When the lower portion of web in the bearing area and the bearing stiffeners have more than 50% combined section loss for non-redundant members or multiple beams with this condition in the same line of bearings.

g. High rocker bearings that are contracted in warm weather or expanded in cold weather.

C. **Safety Flags**

a. Concrete may fall onto under-feature traffic or onto an area where pedestrians or vehicular/railroad/waterway traffic can be present. (Prompt Interim Action as necessary)

b. Exposed curb reinforcing bars or portions of bridge railing protruding into the roadway. (Prompt Interim Action)

c. Leaking combustible gases or liquids on bridges. (Prompt Interim Action)

d. Severely deteriorated or broken inspection catwalks and ladders
e. A significant sized hole in a bridge deck, but there is no threat of structural failure. (Prompt Interim Action)

f. Missing, or illegible vertical clearance sign, where required. Signs which are improperly posted, but are more restrictive, are not Safety Flags.

g. Exposed conductive electrical wiring on light standards on the bridge where pedestrian traffic could be present.

h. Missing or non-functional sections of bridge rail or approach rail. Missing rail is defined as rail that once existed as per plans or other bridge records but at the time of inspection did not exist. If a railing is simply non-conforming to present standards, it shall not be flagged.

i. A hole in a bridge sidewalk.

j. Clear tripping hazard for pedestrians traveling on the Sidewalk areas on the bridge or on the approaches if there is a differential in elevation of 2 inches or greater.

k. Hole or spall in the wearing surface exposing reinforcing bar that can create potential for flat tires.
SAMPLE TRANSMITTAL #1 - "RED FLAG"

Dear ____________________:

This is the written follow-up to the verbal notification made to __________________________ on _______ concerning the Red Flag on BIN _____________________. Attached is a copy of the Bridge Inspector’s Flag Documentation. Our records indicate that you are responsible for taking appropriate corrective action within six weeks from the date of this letter to assure public safety. We request written acknowledgment from you to verify receipt of this notification.

NYSDOT defines a Red Flag condition as one which reports the actual or imminent risk of failure of a major structural component of a bridge, and requires prompt or short term corrective or protective action to assure safety. We further request a written reply by __________________________, 20____ stating what action is being taken concerning the Red Flagged Condition. Such action should be to: 1) close, 2) post, 3) repair, or 4) furnish a written statement that the structure is capable of carrying a legal (as currently posted) load. For those actions which you propose to do in the future, please state what interim action you will implement to ensure the safety of the traveling public.

The Red Flag status will be removed or inactivated upon receipt of written notification that appropriate corrective or protective action has taken place to remove or inactivate the red flag. Such notification shall be accompanied by a certification by a Professional Engineer licensed to practice in New York State, that the corrective or protective actions are appropriate to ensure the safety of the public using the bridge. Such certification shall document that the corrective or protective actions have been a completed and have been inspected or approved, as appropriate, by the engineer. Certification shall include the NYSPE’s name, license number, and mailing address.

Unless we receive written notification and verify that you have taken action to remove or inactivate the "Red Flag" within 6 weeks, we will be compelled to exercise all the authority of this Department to protect the traveling public, which may include the closure of the structure.

Sincerely,

Attachments

cc: BIN File (w/attachments)
    Regional Director
    Main Office Bridge Inspection Unit
SAMPLE TRANSMITTAL #2 - "YELLOW FLAG"

Dear ________________________:

This is written notification that a Yellow Flag has been placed on BIN ______________________ on ______________________, 20 ____. Our records indicate that you are responsible for taking appropriate corrective action to assure public safety. Attached is a copy of the bridge inspector’s Flag Documentation.

The State may withdraw this flagged status if we are provided written certification that the flagged condition has been corrected. Such certification shall consist of a written explanation of the action taken. Such action should be to 1) close, 2) post, or 3) repair. Any such action, except closure, shall be accompanied by a certification by a licensed professional engineer qualified to practice in New York State, that such action is appropriate to ensure the safety of the public using the bridge. Such certification shall document that the corrective or protective actions have been completed and have been inspected or approved, as appropriate, by the engineer. The certification shall include the NYSPE's name, license number and mailing address.

Sincerely,

Attachments

cc: BIN File (w/attachments)
Main Office Bridge Inspection Unit
SAMPLE TRANSMITTAL #3 - "SAFETY FLAG"

Dear ___________________________:  

This is the written follow-up to the verbal notification I made to _____________________________ on ______________, 20____ concerning the Safety Flag on BIN _____________________________. Our records indicate that you are responsible for taking appropriate corrective action to assure public safety. Attached is a copy of the bridge inspector’s Flag Documentation. We also request a prompt written acknowledgment from you verifying receipt of this notification.

Sincerely,

Attachments

cc: BIN File (w/attachments)  
Main Office Bridge Inspection Unit
Dear ________________:

This is the written follow-up to the verbal notification made to ________________ on ________________, 20____ concerning the Red Flag on BIN __________________________. Attached is a copy of the bridge inspectors "Flag Documentation." Our records indicate that you are responsible for taking appropriate corrective action. We request written acknowledgment from you to verify receipt of this notification. We further request a written reply stating what action is being taken concerning the "Flagged Condition." For those actions which you propose to do in the future, please state what interim action you will implement to ensure the safety of the traveling public.

For cases of scour damage, the increased risk of failure due to future flooding or high flows merits special consideration. The presence of such damage clearly suggests the potential for future scour and the existing foundation exposure has reduced the resistance to such scour. We, therefore, strongly recommend that, unless the bridge is closed completely, the undermining be promptly repaired and protected. Until such repairs are made, we recommend that you put the bridge on a local "flood watch" whereby the bridge is observed during periods of high flows with the provision of temporarily closing the bridge under such conditions where the safety of the bridge is in question. We further point out that reducing the live load on the bridge usually has little or no effect in reducing the risk of a scour failure. Therefore, removing or inactivating the flag by posting the bridge or certifying that the bridge is safe "as is" must also include certifying that the bridge can safely withstand future expected flooding in its current condition.

In accordance with NYSDOT procedures, this flag will be removed or inactivated upon receipt of written notification that appropriate corrective or protective action has taken place to resolve the flag. Such notification shall be accompanied by certification of a Professional Engineer, licensed to practice in New York State, that the corrective or protective actions are appropriate to ensure the safety of the public using the bridge. Such certification shall document that the corrective or protective actions have been completed and have been inspected and approved, as appropriate, by the engineer. Certification shall include the NYSPE’s name, license number, and mailing address. We again note the special risks associated with scour damage and the importance of taking prompt corrective actions to repair the damage and minimize the risks due to future flooding or high flows.

Unless we receive written notification by ________________________, 20___ and verify that you have taken corrective or protective measures, we will be compelled to exercise all of the authority of this Department to protect the traveling public. The authority includes closure of the structure.

Sincerely,

Attachments

cc: Regional BIN File (w/attachments)
    Regional Director
    Main Office Bridge Inspection Unit
SAMPLE FBR (Any other substitution, paper or electronic, should have all the details included in this form)

NEW YORK STATE DEPARTMENT OF TRANSPORTATION FLAGGED BRIDGE REPORT

INITIAL: ____________________________
INSPECTOR ____________________________
FLAG NUMBER ____________________________
DATE OF INSPECTION ____________________________

___ RED FLAG*
___ YELLOW FLAG*
___ SAFETY FLAG* 
SUPERSEDES FLAG NUMBER ____________

PROMPT INTERIM ACTION RECOMMENDED _____ YES _____ NO

BRIDGE DESCRIPTION:

BIN ____________  REGION _____ COUNTY ______________________ TOWN ________________

FEATURES: CARRIED ____________________________  CROSSED ____________________________

NUMBER OF SPANS BY TYPE ___________________ APPROXIMATE YEAR BUILT ________________

POSTED FOR LOAD _____ NO _____ YES _____ TONS

IS BRIDGE WHOLLY OR PARTIALLY STATE OWNED? _____ YES _____ NO

DESCRIPTION OF FLAGGED CONDITION (Be specific as to exact nature and location of problem. Include direction of orientation):

Span No ____________  Component __________  Rating _________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

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______________________________________________________________

______________________________________________________________

______________________________________________________________
PHOTOS ATTACHED? __ YES __ NO. IF YES, NUMBER ATTACHED ______

Flagged Bridge Report Completed By ___________________________ Date ______

VERBAL NOTIFICATION: (For Red Flags and Safety Flags with PIA only)

To ______________________ of Regional Office on ______________ at ______ o'clock

To ______________________ (Responsible Party) on ______________ at ______ o'clock

By

_________________________   ____________
Signature of State Team Leader   Date
or Contract Engineer Representative

* The appropriate caption in the upper left of this form shall be initialed by the individual who is the signatory.
NEW YORK STATE DEPARTMENT OF TRANSPORTATION FLAG REMOVAL/INACTIVATION REPORT

REGION/COUNTY ________________ BIN ____________

FLAG NUMBER ________________

_____ RED FLAG CARRIED ________________

_____ YELLOW FLAG CROSSED ________________

_____ SAFETY FLAG

FLAG IS TO BE:

_____ REMOVED

_____ INACTIVATED

CERTIFICATION BY _____________________________

ACTION TAKEN:

REPORT PREPARED BY _____________________________, REGIONAL BRIDGE ENGINEER

DATE ________________
Appendix C

SPECIAL EMPHASIS INSPECTION REQUIREMENTS
SPECIAL EMPHASIS INSPECTION REQUIREMENTS

In addition to conventional visual inspections required for all bridges, certain details and components of metal structures require additional inspection intensity. This additional requirement, known as "100% hands-on" inspection, means that the inspector must get within 2 feet of the component to be inspected. Adequate lighting is also essential. A hand-held spotlight is ideal, but a flashlight is satisfactory if electric power is unavailable. A magnifying glass and mirror should also be used for suspect areas.

With respect to bridge structures, redundancy means that should a member or element fail, the load previously carried by the failed member will be redistributed to other members or elements. These other members have the capacity to temporarily carry additional load, and collapse of the structure may be avoided. On non-redundant structures, the redistribution of load causes additional members to also fail, resulting in a partial or total collapse of the structure.

The New York State Department of Transportation requires that for a bridge to be load path redundant, it must have four or more main load carrying members or load paths. For the purposes of this section, only those structural systems which are load path redundant are considered to be redundant.

A fracture critical member is a member in tension, or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse.

All areas requiring 100% hands-on inspection must be clearly identified in a specially prepared section at the end of the BIN folder. This section must identify location and type of component to be inspected hands-on. Sketches, copies of plan sheets, and/or photos should be used for documentation. For reference during future inspections, the location of any deficiencies found should be noted in the special emphasis section. Also, the binder cover shall have a sticker stating "Special emphasis required during each General or Diving inspection. See BIN folder for general or bridge-specific procedures that apply. Inspections should note any additional special details that warrant attention."

Exceptions to the policy requiring 100% hands-on inspection as stated above can only be granted by the Deputy Chief Engineer (Structures) (DCES). If DCES exemption is granted, then a copy of the Main Office letter must be included in the special emphasis section

When a 100% hands-on inspection occurs under provisions of this Appendix, the Team Leader must note this and indicate the date when performed in the Special Emphasis section of the Bridge Inspection Report. If an exemption has been granted to the "special emphasis" requirement, the items must still be entered and a note added explaining that the exemption was granted and the reason (infinite fatigue life, DCES approval, etc.). Structural or safety related deficiencies indentified by hands-on inspection should be flagged if necessary (See Appendix B).

Unless a written exemption is granted by the DCES, exposed surfaces of the following elements and components must receive a 100% hands-on visual inspection during each general bridge inspection:
1. All non-redundant or fracture-critical metal superstructure and substructure elements subjected to any type of stress condition. These situations include (but are not limited to):
   - Truss chords, gusset plates and diagonals.
   - Main girders of two and three girder bridges.
   - Floorbeams spaced more than 12 feet on-center on trusses or two and three girder bridges.
   - Floorbeam/truss and floorbeam/girder connections if floorbeam spacing is greater than 12 feet on-center.
   - Metal pier caps and pier columns.
   - Anchorage zones of main cables of suspension bridges and the full length of the cables.
   - Floorbeam hanger assemblies regardless of floorbeam spacing (example detail below)

Note:

Steel details that are both fracture-critical and subject to advanced rates of section loss that may be obscured by pack rust should be viewed as a special genre that need to be inspected with more care than what is required for 100% hands-on inspection. For the sake of identifying this class of detail apart from the larger group requiring special emphasis inspection, these details will be referred to as "Special Case Fracture Critical Details" and should be noted accordingly in the inspection report.

Bridge inspectors have to be especially diligent when inspecting such details, keeping in mind that severe section loss can be highly localized and may not be evident without very close scrutiny. Such conditions are not necessarily limited to specialized bridges such as steel arches or to just pin and hanger assemblies. They may also exist in steel trusses and thru-girders, particularly at locations under finger joints and/or in areas that are difficult to inspect. Also, unusual steel details or high skews may result in corners or pockets that may be very difficult to see and where deck leakage with high concentrations of de-icing salt can collect.
When inspecting such details, inspectors must examine and accurately measure the critical components in their current condition if deterioration or other defects warrant such investigation. If this cannot be done, promptly contact the bridge inspection Quality Control Engineer for further guidance prior to closing out the inspection report.

2. All stringers within 3 feet of a stringer/floorbeam connection, regardless of degree of redundancy, if the stringer webs are vulnerable to cracking from fatigue or out-of-plane distortions. The stringer webs are inspected hands-on if all the following conditions exist:
   - The stringer bottom flange bears on, and may be bolted directly to, the floorbeam top flange.
   - The stringer web is unstiffened.
   - Any end diaphragms present do not extend the full depth of the stringer, making the web vulnerable to out-of-plane bending.

The usual failure mode for this type of detail is longitudinal cracking near the bottom of the stringer which is undetectable from beneath the stringer. Failure is more likely under expansion joints where leakage of water, debris, and deicing chemicals accelerate deterioration.
3. All pin-and-hanger details, regardless of element redundancy, and all primary members within 5 feet of the pin-and-hanger details.

4. In tension and stress-reversal areas, all details not in the original design which are vulnerable to fatigue cracks. From the standpoint of crack propagation, any detail welded onto a primary member is considered part of the primary member, including (but not limited to):
   - Tack welds.
   - Welded erection aids.
   - Remaining backup bars at groove welded connections, if the bars are discontinuous.
   - Plug welded holes.

5. All areas of primary members having field-welded repairs of gouges or cracks caused by impact damage or cracks due to fatigue. However, if documentation within the BIN folder indicates the field repair was performed per a NYSDOT approved Weld Procedure Specification and the completed repair was deemed satisfactory through ultrasound inspection, then waiver to 100% hands inspection may be provided by the DCES.

6. Bearing stools:

   The bearing stool detail of concern uses a wide-flange beam section placed vertically (strong axis perpendicular to the beam/girder) beneath a beam/girder end, with an outboard stiffener bracing the stool back up to the bottom flange of the beam/girder (see figure below). The stool, with “mill to bear” ends, and outboard stiffener are attached to the bottom flange of the beam/girder with all around welds. A potential problem exists where the stool bears against its supporting sole plate and bearing assembly. This occurs when only a near-side/far-side fillet weld (along the web of the vertical beam section) positively attached the stool to the sole plate, and the bearing stool’s flanges only bear on the sole plate without positive attachment. (See location of missing welds on below figure.)

   A failure scenario for this bearing stool detail can start with a leaking joint above the stool and the build up of debris around it. In this environment, the stool’s web can rust heavily above and around its fillet weld attachment to the sole plate. Concurrently the same moisture and debris causes the frictional resistance of participating expansion bearings to increase; increasing the horizontal loads applied to the stools. Under the additional horizontal loads, the rusted reduced web section of the stool can distort and tear at its fillet weld attachment to the sole plate. This can result in the stool’s lower web yielding; and the stool’s flanges riding off the sole plate’s edges, dropping several inches as the stool crushes around the sole plate and bearing assembly.

   Welds attaching the stool’s flanges to the sole plate (along with the near-side/far-side fillet welds at the web) would greatly enhance the integrity of this bearing stool detail and extend its lifecycle. During an inspection, the absence of existence of such flange welds should be verified by the inspector. When no welds are found attaching the stool’s flanges to the sole plate; the inspector should: a) document (in the inspection report) the absence of the welds, and the present loss of section and distortion of each stool inspected; b) identify the stools without flange to sole plate welds as requiring a “special emphasis” (100% hands-on) inspection. Any stool missing the flange to sole plate welds and showing significant deterioration should be structurally flagged.
Bearing Stool Detail

OUTBOARD STIFFENER

MISSING WELDS

SECTION A-A

BEAM / GIRDER

OUTBOARD STIFFENER

WF SECTION

SOLE PLATE

BEARING ASSEMBLY

(SUBSTRUCTURE)

MISSING WELDS

C.6
7. Thru-Girder Shear Splice:

Multi-span in line thru-girders, in certain cases, have shear splice connections which warrant particular concern. The connection in question is usually located adjacent to a pier bearing with only one end of the two girders being connected directly supported by the bearing. There is no web continuity between girders. The girder end not directly supported by the bearing is primarily dependent on the shear capability of the connection. This shear splice utilizes angles riveted and/or bolted to both faces (near and far sides) of the web at the ends of both girders. The outstanding legs of these angles are riveted and/or bolted back-to-back, connecting the ends of the two girders. Failure of this connection would most likely cause superstructure collapse. See figure below.

When inspecting thru-girder bridges with this detail, the following should routinely be done:

A. Thoroughly inspect each fastener for any signs of distress such as looseness, corrosion, bending, etc. and note any distress.
B. Thoroughly inspect 2 feet from both sides of the centerline of the connection for cracks or tears in the structural elements that make up the thru-girders. Attention should be given to cracks that could emanate from bolt and/or rivet holes.
C. Inspect the zone as described in B for crevice corrosion.
D. Inspect for any other signs of distress such as displacement of the connection, deformation of structural members, alignment and profile of members, etc.
E. Document the connection and its condition with sketches (if plans are not available), measurements, and photographs using clear, concise descriptions.

This list represents a set of general steps that are to be followed as a guide when a bridge with this detail is encountered. Since all bridges should be treated as unique, more steps may be required in some cases; therefore, these steps are to be considered as a minimum.
8. Details vulnerable to cracking from out-of-plane distortions. These include (but are not limited to) girder webs at girder-floorbeam connections (especially on skewed bridges), and coped or blocked floorbeam details.

9. Concrete Deck Haunch:

Certain concrete deck haunches require 100% "hands-on" inspection. In this detail, the concrete haunch extends past the edges of the top flange (haunch is wider than top flange), with the bottom face of the concrete haunch flush with the bottom face of the top flange. This generally results in a 90° edge of unreinforced concrete that is prone to spalling.

This detail was used in removable bridge deck forming systems and has caused failures resulting in falling concrete. In some cases, the unreinforced parts of the haunch have cracked and fallen, thus creating a hazard to traffic beneath the bridge. Apparently, the failures occur due to forces resulting from corrosion products on the edge of the flange. The crack initiates at the edge of the flange and propagates upward at approximately 45° before intersecting the vertical haunch face, thus resulting in loose concrete. The inspector should be very careful to look for hairline longitudinal cracks along the vertical face of the haunch as shown in the below figure.

HAUNCH DETAIL

LIKELY LOCATION OF CRACK FORMATION
When performing the inspection of a bridge with this particular haunch detail, 100% "hands-on" inspection is required on every haunch for sections of structures over highway, pedestrian, railroad and/or waterway traffic. This 100% "hands-on" inspection should include sounding of the haunch with a hammer. The findings should be documented in the inspection report. Cracks or loose concrete on the haunches should be safety flagged.

10. All AASHTO Category D, E, and E' welded details:

Unless a written exemption is granted by the DCES or calculations are performed and checked to estimate sufficient remaining Minimum Expected Fatigue Life, exposed surfaces of all AASHTO Category D, E, and E' welded details (see AASHTO LRFD Bridge Design Specifications, Chapter 6 for examples) must receive a 100% hands-on visual inspection during each inspection. Regardless of exemption herewith, these welded details must receive a 100% hands-on visual inspection every 6 years with the exception that partial length cover plate welds may be inspected every 12 years.

The analysis methods to be used are in the AASHTO Manual for Bridge Evaluation, Chapter 7 where the Minimum Expected Fatigue Life is defined as the time interval in which there is a 2% probability of detail failure. Traffic counts more than 10 years old may not be used, unless there is evidence that traffic on the bridge has not increased.

Automatic exemptions from the 100% hands-on requirement will apply to redundant members only when:

- The calculated Minimum Expected Fatigue Life is 10 to 50 years. Reanalysis shall be performed using current traffic count data every 6 years (12 years for partial length cover plate welds).
- The calculated Minimum Expected Fatigue Life is greater than 50 years. Reanalysis is not necessary unless traffic increases by more than 6 percent annually. If the traffic growth is greater, then reanalyze every 6 years.

For Minimum Expected Fatigue Life less than 10 years, the DCES will grant exemption from the 100% hands-on requirement only on a case-by-case basis if appropriate.

If the DCES ‘case-by-case’ exemption is granted, then a copy of the exemption letter must be included in the BIN folder special emphasis section. If exemption is automatic because of fatigue-life calculations, then a copy of the calculations must be placed in the BIN folder special emphasis section. If calculations indicate no exemption, then a note must be placed in the BIN folder special emphasis section stating this and the reason (e.g. traffic count greater than 10 years old, calculated minimum expected fatigue life less than 10 years, etc.). The persons performing and checking the calculations must be identified. There must also be a comment in the Inspection Report noting why the 100% hands-on requirements have been waived.

11. Bridges with Staggered Diaphragms:

Plate girders with thin webs (<0.4") and staggered diaphragms have shown a tendency to form web cracks adjacent to the connection plate snipe due to out of plane bending. The cracks tend to run both horizontally along the flange to web fillet weld and vertically along the connection plate to web fillet welds.
In general, these cracks can be detected by a hands-on visual inspection. Any areas of the web that exhibit oxide staining of the paint or paint creases should be thoroughly inspected.

The below figure is a framing plan that shows the staggered diaphragm layout and typical crack locations.
12. Movable Bridge – Trunnions:

Trunnions, cylindrical protrusions used as a mounting and/or pivoting point, are typically designed for bending, bearing and shear stresses based on the nominal section at the bearing. For certain lift bridge designs, little or no consideration was given to abrupt changes in section, which are ‘stress risers’ susceptible to fatigue cracking.

The potential for a catastrophic failure due to a fractured trunnion should be recognized by engineers responsible for inspecting bridges. In regard to movable bridges, a thorough 100% hands-on inspection shall be made of trunnions that have incorporated an abrupt change in section, especially in cases where the trunnion is subjected to more than 90 degrees of rotation under normal operating conditions. See figure below.

Any indication of cracking in a trunnion shall be structurally flagged. Additional guidance in identifying trunnions may be found in the FHWA BIRM.

13. Fiber Reinforced Polymer (FRP) Wrap:

FRP wrapped bridge elements require 100% hands-on inspection to adequately discern their condition and efficacy. FRP wrap documentation may be in the BIN folder, but can generally be identified by the grid pattern found in the fiber reinforcing sheets.

The inspector’s most effective method in determining the condition of an FRP wrap repair is to lightly tap the repaired area with a hammer, listening for hollow sounds which may indicate
inadequately bonded FRP layers. The inspector should also watch for excessive deflection which may indicate continued deterioration of the underlying material or debonded pockets of air entrainment. Efflorescence and rust may bleed through the wrap which indicates continuing deterioration of the treated area. This should be documented accordingly.

Any loss of bond of an FRP wrap functioning in a structural capacity is a serious condition and should be flagged until such time that further investigation and evaluation can be performed. Loss of bond of an FRP wrap functioning in a non-structural role, such as splash zone protection, is still serious but does not merit a flag condition. Provide a sketch in the inspection report and/or flag documenting the location and extent of FRP delamination.

Newly found locations of FRP wrapping identified in the course of an inspection shall be documented in the special emphasis section of the BIN folder.

14. Steel Web Bearing Area

Primary member bearing areas, where combined web and bearing stiffeners (when present) loss meets or exceeds 25%, require 100% hands-on inspection.

The primary member bearing area is the web design strip length including bearing stiffeners (when present) for 8 inches above the bottom flange that is directly over the bearing. The web design strip length, 18 times the web thickness (for example: 0.625 inches x 18 = 11.25 inches), is considered as effective with the bearing stiffeners in acting as a column to transmit the entire beam reaction load to the bearing.

Although all built up plate girders require bearing stiffeners, AASHTO only requires bearing stiffeners on rolled beams when the shear at the bearing exceeds 75% of the allowable shear of the web. The web over the bearing acts like a thin column by itself to support the beam reactions and to transfer the loads to the bearings. Therefore, the area of the beam directly over the bearing is susceptible to failure due to loss of section from corrosion, especially for rolled beams without bearing stiffeners.

Bridge inspectors should note that some of the bridges without bearing stiffeners have connection plates in or near the bearing area that might be confused with bearing stiffeners. Connection plates are of limited benefit in reducing the possibility of web distortions and should not be confused with bearing stiffeners.

When corrosion is present, the inspector should measure and document the extent of that corrosion and section loss. Where loss of bearing area exceeds 25%, the corroded bearing area shall be well documented, preferably with a sketch.

For all cases, where there is more than a 50% section loss to the bearing area, the inspector shall consider issuing a structural flag based on condition, redundancy, loading and engineering judgment for each circumstance.
15. Complex Bridges

Title 23 of the Code of Federal Regulations, Part 650, Subpart C-National Bridge Inspection Standards, requires that specialized inspection procedures be identified for "complex bridges". The Code defines complex bridges as "moveable, suspension, cable stayed, and other bridges with unusual characteristics".

The designer of complex bridges, or of bridges that incorporate innovative or unusual elements or details, shall identify those bridge elements or details that warrant specialized inspection attention. A "Special Emphasis Inspection Procedure" (SEIP) shall be assembled, submitted with the "Final Bridge Plans", and stored in the BIN folder.

Complex bridges shall be inspected according to the bridge SEIP and by inspectors with additional training and experience specific to that SEIP. The inspector of complex bridges, or of bridges that incorporate innovative or unusual elements or details, should note any additional special details that warrant attention, by adding them to the SEIP listed below and stored in the BIN folder.

The BIN folder cover of a Complex Bridge shall have a sticker stating “Complex Bridge Special Emphasis Required. See BIN folder for general or bridge-specific procedures that apply. Inspections should note any additional special details that warrant attention.”

The contents of the SEIP shall be as follows:

- A brief statement of purpose presenting an explanation of why the SEIP is required.
- Characterization of the complex of unusual elements or details to be given special attention; a description of the element or detail and the reason(s) it is considered complex or unusual.
- A description of how the element or detail should function or behave and a description of the physical conditions that can be observed that would indicate that the element or detail is functioning appropriately.
- A description of the observable physical characteristics that would indicate that the element or detail is not functioning appropriately along with direction relative to how to assess the degree to which the element or detail is faulty in its performance.
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Appendix D

DIVING INSPECTIONS AND FATHOMETER SURVEYS
Diving Inspections and Fathometer Surveys

Table of Contents:

<table>
<thead>
<tr>
<th>Section 1</th>
<th>1</th>
<th>Diving Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.1</td>
<td>Diving Inspection Intensity</td>
</tr>
<tr>
<td></td>
<td>1.2</td>
<td>Diving Inspection Frequency</td>
</tr>
<tr>
<td></td>
<td>1.3</td>
<td>Scour Documentation</td>
</tr>
<tr>
<td></td>
<td>1.4</td>
<td>Protection Systems</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>Damage Evaluation</td>
</tr>
<tr>
<td></td>
<td>1.6</td>
<td>Special Considerations</td>
</tr>
<tr>
<td></td>
<td>1.7</td>
<td>Diving Inspection Report Documentation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 2</th>
<th>2</th>
<th>Fathometer Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.1</td>
<td>Fathometer Survey Limits</td>
</tr>
<tr>
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<td>2.2</td>
<td>Fathometer Survey Frequency</td>
</tr>
<tr>
<td></td>
<td>2.3</td>
<td>Field Procedures</td>
</tr>
<tr>
<td></td>
<td>2.4</td>
<td>Fathometer Survey Report Documentation</td>
</tr>
</tbody>
</table>

In addition to the pertinent sections of chapters 1, 2, 3, and 4 of the Bridge Inspection Manual, this appendix provides guidelines and instructions for diving inspection teams and fathometer survey crews in conformance with the New York State Department of Transportation (NYSDOT) diving inspection and fathometer survey program based on Part 165.4(b) of the Uniform Code of Bridge Inspection.
Section 1: Diving Inspection

1.1 Diving Inspection Intensity

Diving inspection is a detailed, visual and tactile inspection of a substructure unit (SSU) which may require partial cleaning. All surfaces of underwater components (e.g., footings, piles, stems, scour protection devices) are inspected and all anomalies such as section loss, voids, holes, etc. are measured. The diving inspection may use nondestructive testing procedures when specified and approved by Deputy Chief Engineer (Structures) (DCES).

Nomenclature of SSUs shall conform with the New York State bridge inventory.

Diving inspection shall be done by surface supplied air. Continuous audio and video communications link with the top-side crew shall be maintained.

Due to safety and/or efficiency concerns, some diving environments may require the divers to be substituted with an equivalent inspection means after receiving approval from DCES.

Impediments, such as debris or lock-down procedures, shall be mitigated before completing the inspection. When mitigation requires extensive resources, the available portion of an SSU may receive a partial inspection after receiving approval from DCES.

The use of additional personnel, equipment or procedures which are not considered the commonly-used methods, will require approval from the DCES.

The physical limits of the diving inspection are from 3 feet above the water surface to the accessible portion of the substructure below water, at the time of the diving inspection.

1.2 Diving Inspection Frequency

The diving inspection frequency is based on the General Recommendation determined during the Bridge Diving Inspection, as follows:

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>DIVING INSPECTION FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSU General Recommendation of 1 or 2, or active structural flag due to a diving condition</td>
<td>12 months</td>
</tr>
<tr>
<td>SSU General Recommendation of 3</td>
<td>24 months</td>
</tr>
<tr>
<td>SSU General Recommendation of 4 or higher</td>
<td>60 months</td>
</tr>
</tbody>
</table>

Some conditions may necessitate an inspection frequency other than the above. The recommendation to do a diving inspection may be made by the Regional Hydraulics Engineer in concurrence with the Regional Structures Management Engineer (RSME).
1.3  Scour Documentation

Soundings (water depth readings):
See chapter 4B.2

Probings along the SSU perimeter and perpendicular to the SSU:
Using a probing tool such as a steel rod, check for soft areas in the streambed along the substructure, recording the depth of penetration. These probing measurements should be equally spaced between the ends of the substructure, at increments not to exceed 10 feet; the locations should coincide with previous inspection readings. The cross-section measurements shall consist of 6 readings at 2 ft. intervals perpendicular to the exposed outer edge of the SSU with one reading at the edge: the sketches should locate the edge relative to the SSU stem. In the “Probing and Sounding Plan” illustration, the stationing is measured along the face of the stem but the probing and sounding measurements begin from the face of the sheet piling.

1.4  Protection Systems

Fenders, dolphins and other devices which protect the substructure from impact, shall be inspected for misalignment, damage, missing elements, assessment of the physical condition of the material and other anomalies. Assessment of all protective devices shall be included in the ratings for the nearest substructure on the rating forms: the backwall and stem ratings for an abutment, stem and column ratings for a pier.
1.5 **Damage Evaluation**

See the BIRM for scope details for damage due to environmental or accident related issues such as: floods, vessel impact, ice floes, propeller wash from vessels, buildup of debris, and evidence of movement or deterioration.

1.6 **Special Considerations**

See the BIRM for issues with debris, SSU cleaning, physical limitations, decompression sickness and marine traffic.

1.7 **Diving Inspection Report Documentation**

**Site Conditions**

Dry Exception: for an SSU scheduled for a diving inspection which no longer meets the diving inspection criteria: the diving inspection team will satisfy the requirements of BIM chapter 4B.2 or chapter 4B.3. Photographs of the SSU in elevation view should demonstrate that a general inspection team can adequately inspect this SSU.

Low Freeboard Condition: this condition exists when height between the lowest part of the superstructure and the water surface is two (2) feet or less. For tidal waters, if the inspection team is present, the water surface elevation at high tide and/or at low tide should be shown on the elevation sketch.

Evidence of High Water: some structures may show signs of a higher water surface elevation such as debris lodged in the superstructure, erosion of adjacent embankment and discoloration of vegetation on adjacent embankment. The height above the current water elevation should be noted including the supporting observation.

Water Velocity: this is an approximate measure of water flow for the SSU being inspected.

Water Visibility: this is the depth of vision available to the diver: good (2 feet or greater), fair (6 inches to 2 feet), poor (6 inches or less).

Marine Growth: this defines the extent of SSU surface which is available for inspection: negligible (10% or less of surface area), moderate (10% to 50%), heavy (50% or greater). When the growth is defined as moderate or heavy, the Team Leader should determine the need for cleaning with water-blasting equipment.

Polluted Water: this should be noted with supporting observation: smell, surface/water discoloration, foam, etc.

Improvements Observed: examples may include scour mitigation, repair, replacement or additions to the SSU. Scour mitigation examples include stream realignment, riprap/grout-bag repair and debris removal.
Maps and Photographs

Two location maps shall be provided:
- The first map shall be a general map showing the region and county, locating the bridge by BIN.
- The second map shall be a "street" map (USGS 1"=2000') showing the location of the bridge by BIN.
- Both maps shall have North Arrows and shall be adequately sub-titled.
Sufficient information should be detailed for a motorist to locate the BIN site.

Condition Photographs:
The photographs shall have an accurate date stamp (format: month/day/year) electronically imprinted at time of capture. The photographs shall be reviewed for content, clarity and perspective prior to being placed in the inspection report. Generally, photograph content should not be altered electronically or otherwise. Minor adjustments in exposure and the addition of text, lines or arrows for clarification and emphasis are acceptable.

Condition photographs document deficiencies and must be taken:
- When elements are rated 4 or lower.
- For repaired or new bridge elements.
Condition photographs shall include a brief description of what is being represented (e.g.: "Pier 1, column 3 spalling, looking left") and a cross-reference to written comments in the inspection report, if any. Include a photo location plan for all condition photographs in the inspection report. See figure 2.5.4.1 for an example.

Standard photographs typify the feature being represented:
- General configuration of each SSU
- Any unusual components or details, including (but not limited to) dolphins and fenders.
Section 2: Fathometer Surveys

A fathometer survey is a topographic representation of the channel bottom at the bridge. Comparison with the previous survey identifies any progressive scour activity and any related stream channel aggradation and degradation.

2.1 Fathometer Survey Limits

The limits of the fathometer survey shall be:
- 100' upstream of the upstream structure fascia.
- 100' downstream of the downstream structure fascia.
- the full width of the waterway: edge-of-water to edge-of-water.

At a minimum, measurements shall be made at the intersection of lines that are:
- parallel with the centerline of the bridge at 20' intervals measured in a line perpendicular to the centerline of the bridge.
- perpendicular with the centerline of the bridge at 20' intervals measured in a line parallel to the centerline of the bridge.

Measurements shall be made at the faces of all submerged substructure units (SSUs); contours should end at the face of the substructure unit.

2.2 Fathometer Survey Frequency

The fathometer survey frequency is based on the hydraulic needs of a structure as determined by the Regional Hydraulics Engineer in concurrence with the Regional Structures Management Engineer (RSME).

2.3 Field Procedures

The following approved method of performing fathometer surveys may be substituted. The alternate method shall yield equivalent or better data precision, and shall cost less than or equal to the approved method.

- Existing permanent horizontal control points and benchmark(s) on the structure shall be referenced. Permanent horizontal control points and benchmarks shall be established if previous points are not available. However, if a more appropriate benchmark is to be used, this change shall be supported with sufficient documentation.
- Baseline stations shall be established at appropriate locations within the fathometer survey limits.
- Bridge SSUs and pertinent data shall be located from baseline stations via angle/distance method for horizontal control.
- The transducer arm shall be mounted on the boat so that the prism is continuously visible from the baseline stations.
- Water elevations and depth checks shall be frequently compared with survey data being generated.
- The fathometer unit shall be calibrated before every survey.
2.4 Fathometer Survey Report Documentation

The top right hand corner of every page shall display: Fathometer Survey, BIN, Region & County, Feature carried, Feature crossed.

Fathometer Survey Report shall be assembled in the following sequence:

- Cover sheet shall be formatted as follows:
  - page center shall show the title in bold: line 1: “New York State Department of Transportation,” line 2: "date by year" FATHOMETER SURVEY."
  - in the bottom right hand corner, the Quality Control Engineer (fathometer survey representative) shall sign the reviewed by line, print the name and the title.
  - in the bottom left hand corner, the name of the Prime Consultant and the address shall be shown. If the Subconsultant and/or the Subcontractor are involved, their name and address shall also be shown.

- Location Maps:
  - The first map shall be a general map showing the region and county, and locating the bridge by BIN, with appropriate labeling.
  - The second map shall be a “street” map (USGS 1"=2000’) showing the location of the bridge by BIN. This will be larger than the first map.
  - Both maps shall have North Arrows and shall be adequately sub-titled.

Sufficient information should be detailed for a motorist to locate the BIN site.

- Flag letter and flagged bridge report.

- Standard Photographs: appropriately labeled photographs of upstream and downstream views as seen from the structure fascias.

- Narratives and Notes:
  - Introduction will briefly describe the bridge: number of SSUs, length and width of the bridge, navigable waterway, tidal waters, approximate water velocity and its location, unusual features and conditions, weather, survey crew personnel, location and elevation of benchmarks.
  - The narrative will describe in detail the highest and lowest elevations, and locations of consecutive contour accumulations for the current fathometer survey with emphasis on potential or existing scour holes: these should match the points displayed on the contour plot.
  - For bridges with previous fathometer survey data, a comparative analysis shall compare the current fathometer survey to the previous fathometer survey(s) and to the as-built information. This comparative analysis must, at a minimum, address the differences or similarities between the fathometer surveys in terms of erosion, build-up of material, loss of embedment length, etc. Recommendations for corrective actions and the frequency of fathometer surveys shall also be stated.

- Movement of channel-bottom will be shown in a table:
  - SSU Identification
  - Minimum channel-bottom elevation location
  - Minimum channel-bottom elevation
  - Historic minimum channel-bottom elevation: usually the elevation at time of SSU construction
- Year of historic minimum channel-bottom elevation
- Change in channel-bottom elevation
- For substructure units on piles:
  - Pile tip elevation.
  - Pile embedment length
If SSU foundation information is not available, state “Unknown”.

- Activity Log shall consist of:
  - Type of access: shore, boat, etc.
  - Boat launch location address and travel time to and from the bridge site
  - Unusual conditions should be explained
  - Special contacts for access or coordination
  - Name of consultant and surveyor performing the fathometer survey
  - Area of fathometer survey
  - The following can be tabulated: date, arrival and departure time from the bridge, temperature range, weather (including wind condition), relevant site comments

- The fathometer survey plot shall include:
  - a D-sized contour map (34”x22”) showing the outline of:
    - the bridge fascias.
    - SSUs. The contour lines shall close or "touch" an SSU face. SSUs shall be labeled in accordance with New York State bridge inventory
    - Centerline of the roadway carried by the bridge.
    - For parallel structures, the plot should show the outlines of the adjacent structure’s: fascias, SSUs, roadway centerline
    - stream with streambed elevations at 1’ intervals. Shoreline (edge of water) should be demarcated to clearly distinguish from the contour lines
  - a North arrow.
  - plot scale.
  - location maps (see earlier definitions).
  - sketches that clearly locate the baseline, and the horizontal and vertical control points. The level of information shall be sufficient to establish these references for future surveys.
  - sketches shall show bottom of footing elevation. If the SSU is on piles, the sketch shall also show as-built pile-tip elevation and the as-built embedment length.
  - for each SSU, location of minimum channel-bottom elevation shall be identified
  - for an SSU on piles, pile with the least pile embedment shall be identified
  - location notes on benchmarks, and the horizontal and vertical control points.
  - approximate high water line with direction of stream flow (tidal flow direction, as applicable).
  - spot elevations should be shown to emphasize a contour pattern such as a scour pocket. The highest point of a mound or the lowest point of a depression, should be identified with a “+” and labeled with the associated elevation.
  - survey dates should be noted.
  - plot shall be signed and dated by the Fathometer Surveyor and the Quality Control Engineer.

All fathometer readings shall be converted to elevation values, based on an established benchmark on the structure.
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Appendix E

MOVABLE BRIDGES
MOVABLE BRIDGES

Generally, inspection of mechanical and electric components of movable bridges is beyond the scope of general bridge inspections, but structural components of movable spans must be inspected with the same intensity and frequency required for conventional bridges. Therefore, movable bridges shall receive general bridge and diving inspections the same as required for conventional bridges. Additionally, the interaction between the movable bridge and the machinery will also need to be addressed because the mechanical/structural interaction is important for adequate inspection and maintenance of the machinery.

Inspection of electrical and mechanical components necessary for the safe and proper operation of movable bridges is the responsibility of the agency that operates the bridge. These inspections shall take place at a maximum frequency of 72 months (6 years) unless the deterioration or conditions warrant more frequent inspections.

A movable bridge should have its own Operation and Maintenance Manual, although these documents may not be readily available at the bridge site. If the Operation and Maintenance Manual is available, the inspection team should review the manual to determine if there are any special conditions that are exhibited on the bridge. If there is no Operation and Maintenance Manual, sound judgment should be used where specific conditions are encountered that are not covered by this manual.

Note that movable bridges are considered “complex bridges”. See Appendix C for guidance regarding 100% hands-on inspection and associated BIN folder documentation requirements.

Additional information regarding movable bridges may be found in the AASHTO Movable Bridge Inspection, Evaluation and Maintenance Manual and the FHWA Bridge Inspector’s Reference Manual.
Appendix F

SUSPENSION BRIDGES
SUSPENSION BRIDGES

Most suspension bridges are large, unique structures that require specialized bridge-specific inspections according to specifications provided by the owner. If there are no specific instructions to the inspector, use the following information and the guidelines in the FHWA Bridge Inspector’s Reference Manual and the FHWA Primer for the Inspection and Strength Evaluation of Suspension Bridge Cables (Publication No. FHWA-IF-11-045). Note that suspension bridges are considered “complex bridges”. See Appendix C for additional information regarding 100% hands-on inspection and associated BIN folder documentation requirements.

All suspension bridges have common features that the inspector needs to be aware of. The superstructure is supported by vertical suspenders, which in turn, are supported by a main suspension system. That system usually consists of two or more large cables, but eyebar chains may be found on older or smaller bridges. The suspension system is in tension and requires substantial end anchorage with at least one intermediate pier support. The main suspension system is considered fracture-critical, and load-path non-redundant, thus requiring special inspection techniques.

Eyebar chains must be inspected with the same inspection intensity as any fracture-critical tension member. The entire chain length must be inspected 100% hands-on. This type of detail is particularly vulnerable because steel used for eyebars often has poor notch toughness; therefore the chains are susceptible to cracks. The likelihood of corrosion especially at the connections, contributes to the vulnerability of this type of system.

Full hands-on inspection of main suspension cables may not be necessary because they are fabricated from many individual strands and thus have a high degree of internal redundancy. It is, however, necessary to give special consideration to these components and if the detected conditions so warrant, a full 100% hands-on inspection may be required. The inspector should walk along the entire length of the cable to assess the condition of the wrapping, cable bands, and the suspender to cable band connections. A mirror mounted on the end of a stick or pole is used to inspect the cable underside. Any corrosion on the cable underside may be very serious — water may be leaking through the cable.

At the splay casting, the main cable divides into smaller strands. All accessible wires and anchor bars in this area (anchorage zone) shall be inspected 100% hands-on. Document carefully and thoroughly, any broken or corroded wires or anchor bars.
Appendix G

REQUIRED TOOLS AND EQUIPMENT
REQUIRED TOOLS AND EQUIPMENT

Each team performing general bridge inspections must have proper tools available at the site. Additional equipment may be required and should be available on an as-needed basis. All tools must satisfy OSHA requirements.

As indicated in the most current version of the FHWA Bridge Inspection Reference Manual: Several factors play a role in what type of equipment is needed for an inspection. Bridge location and type are two of the main factors in determining equipment needs. If the bridge is located over water, certain pieces of equipment such as life jackets and boats may be necessary on-site. Also, if the bridge is made of timber, then specific pieces of equipment like increment borers and ice picks are needed, whereas they would not be necessary on a steel or concrete bridge. Another factor influencing equipment needs is the type of inspection. It is therefore important to review every facet about the bridge before beginning an inspection. A few minutes spent reviewing the bridge files and making a list of the necessary equipment can save hours of wasted inspection time in the field if the inspectors do not have the required equipment.

Each team should be equipped with the following:

- Work-zone protection and traffic control equipment, including signs, traffic cones and flags.
- Personal safety equipment including first-aid kit, hard hats, vests, goggles, face shields, full body harnesses, and lanyards.
- Basic access equipment such as a step ladder, extension ladder and rope.
- Tools for cleaning, including a whisk broom, wire brush, scraper, shovel and broom, heavy duty garbage bags to dispose of removed debris, and disk and die grinder.
- Tools for inspection, including chipping hammers, pocket knives, screwdrivers or awls, increment borer, magnifying glass, binoculars, flashlights, lead or drop light (including 110 VAC power source), mirrors, tool belt, etc.
- Tools for measuring, such as a plumb bob, protractor, levels, folding rules, tapes, calipers, pocket rulers, thickness gauges, optical crack gauge, D-meter, scour probing rods, vertical clearance rod, weighted sounding lines, thermometer, laser distance measuring device, tilt meter, etc.
- Tools for documentation, such as a digital camera with electronic flash, triangles, straight edges, steel scribes, center punches, engineer/architect scales, magnetic compass, inspection forms, inspection software and computer, etc.
- Cellular phone, internet access Air Card, and list of emergency contacts.
- Consumable supplies, including lumber crayons, spray paint, zinc-rich primer, dye-penetrant test materials (penetrant, cleaner, developer, rags), camera batteries, disposable dust/nuisance respirators, etc.
- GPS
Each team should have access to the following equipment as-needed:

- Equipment for working over water, such as life jackets, waders, one or more ring buoys with at least 115 feet 35 m of attached line, and if necessary an approved skiff which is properly equipped and manned with a trained operator.
- Drills or ram-set guns and epoxy adhesive for mounting BIN plates.
- Personal protective equipment such as rain suits, gauntlet gloves, rubber boots, etc.

Each Team Leader and Quality Control Engineer shall be equipped with the following manuals:

- **NYSDOT’s**
  - Bridge Inspection Manual (with Technical Advisories)
  - Bridge Inspection Safety Manual
  - Bridge Inventory Manual
- **AASHTO’s**
  - The Manual for Bridge Evaluation
- **FHWA’s**
  - Bridge Inspector’s Reference Manual

These publications shall be available for reference in the field.
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Appendix H

LEAD PAINT CONTAINMENT
LEAD PAINT CONTAINMENT

Environmental lead contamination is of increasing concern. Lead-based paint used on bridges can contribute to this contamination. While the impact of general bridge inspections on lead contamination levels is minimal due to the nature and volume of waste produced, NYS DOT will make every effort to avoid contributing to potential public health concerns as a result of its bridge inspection activities.

Paint debris released as a consequence of general bridge inspection must be collected, labeled, and disposed of properly. The debris should be collected in buckets or other suitable containers as it is produced by using brooms or other devices to prevent it from dropping below the bridge. If debris drops below the bridge, all reasonable and prudent steps must be taken to collect it. The collected debris should be disposed of under contract or removed from the site for disposal as directed by the Region, in conformance with State and Federal regulations.

Refer to the New York State Department of Transportation Bridge Inspection Safety Manual for additional guidelines on lead paint.
TECHNICAL ADVISORIES

Technical Advisories (T.A.’s) are a form of communication used by the Office of Structures to provide technical information to those involved with bridge inspection activities.

Some T.A.s issued have been superseded by this manual. Listed below are bridge inspection Technical Advisories that remain in effect as of the issuance of this manual:

INSPECTION

85-001 Introduction to Technical Advisory

The following T.A.’s are superseded by this manual:

INSPECTION

86-002 Inspection of Non-Bearing-Centered Connection of Select In Line Thru-Girders
86-004 Air Quality Testing of Confined Spaces
86-005 Culvert Inspection Manual Report No. FHWA-IP-86-2
87-004 Investigation of Trunnion Failures Involving Movable Bridges
87-005 Inspection of Fracture Critical Bridge Members-Supplement to Bridge Inspector Training Manual" - FHWA-IP-86-26
87-006 Bridge Inspection Checklist
87-007 Bridge Inspector's Manual for Movable Bridges - FHWA-IP-77-10
87-013 Providing Bridge Owners with Bridge Inspection Reports
88-001 Shadow Vehicle Policy
88-002 Inspection of Bridge Bearing Stools
90-001 Inspection and Evaluation of Truss-Floorbeam Hanger Connections
94-004 Steel Special Emphasis Stringer Connections
96-001 Policy for the 100% "Hands-On" Inspection of Haunch Details
96-002 Prestressed Concrete Beam Cracking
96-003 Additional Procedures for Inspection Fall Protection
98-001 Review and Identification of Information in BIN Folder of Bridges Affected by Tidal Scour in Regions 10 and 11
00-001 Special Case Fracture Critical Details
02-001 Bridges with Staggered Diaphragms
05-001 New Inspection and Monitoring Requirements for High Rocker Bearings
06-001 Bridge Inspection Guidelines for Inspection in the Bearing Areas of Corroded Primary Members
12-002 Fatigue Evaluation 100% Hands-On Exemption
13-001 Types and Required Intervals of Bridge and Diving Inspections

INVENTORY

86-001 Vertical Clearance Measurements for Bridges Spanning Railroads
Represented here is a new form for communication from the Structures Division. Entitled TECHNICAL ADVISORY, abbreviated as T.A., it will provide technical information to those involved with bridge Inventory, Inspection, and Level Two Load Rating activities.

Attached are copies of blank Inventory, Inspection, and Level Two Load Rating T.A. forms, differentiated by the shaded unit title boxes located along the right hand side of each page. The smaller box, below the unit title box, will contain the last two digits of the year issued plus a three digit T.A. issue number. Should a particular T.A. need revision, then a new T.A. will be issued with the year and T.A. number that it supersedes in the “Supersedes” box in the heading. At the end of each year, an index for that year's issuances will be printed for reference.

Issuance of all T.A.'s will be from the appropriate unit or sub-unit within the Structures Division. During training sessions, each attendee will receive a copy of all current T.A.'s. A normal issuance to the Regions will each consist of copies to the Regional Director, Regional Structures Engineer, Regional Bridge Inventory Coordinator and State Employee Bridge Inspection Team Leader, Assistant Team Leader and Senior Engineering Technicians. Current issuances will be given to all new Contract Engineers by the Structures Division at project start up meetings.

However, after the start up meeting, it will be the Regional Structure Engineer's responsibility to distribute any new T.A. issuances to onboard Contract Engineers.

Suggestions from Regions for possible issuance of a T.A. are encouraged. Suggestions should be sent to the appropriate unit in the Structures Division for consideration.

Questions concerning this T.A. should be addressed to the Inventory and Inspection Unit in the Structures Division.
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Appendix J

USING THE FEDERAL SCALE
USING THE FEDERAL SCALE

Introduction

In order to accurately supply the Federal Highway Administration with required bridge condition information, it is necessary to collect the data directly in the field using the Federal Rating Scale. Inspectors will need to follow the instructions in the FHWA “Bridge Inspector’s Reference Manual” and the "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges" (Report No. FHWA-PD-96-001) when filling out the Federal Rating Form for all bridges. For each bridge, the inspector rates five items using the federal scale: deck, superstructure, substructure, channel and channel protection and culvert. When rating these items, the inspector shall consider the condition of the entire bridge and not rate the item using the "worst of multiple elements" concept as described in Chapter 2 of this (NYSDOT) manual. Refer to the FHWA “Bridge Inspector's Reference Manual” for further directions on item rating. This appendix contains the complete FHWA rating information (reprinted below verbatim) as described in the FHWA "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges" and is annotated in italics to clarify areas of possible confusion arising from differences between the FHWA and NY State inspection procedures. Inspectors should not use a table to convert from the NYSDOT rating to FHWA rating and instead provide an NBI rating based on the following condition descriptions:

Federal Rating System

Item No. 58 through Item No. 62 - Indicate the Condition Ratings

In order to promote uniformity between bridge inspectors, these guidelines will be used to rate and code Items 58, 59, 60, 61, and 62.

Condition ratings are used to describe the existing, in-place bridge as compared to the as-built condition. Evaluation is for the materials related, physical condition of the deck, superstructure, and substructure components of a bridge. The condition evaluation of channels and channel protection and culverts is also included. Condition codes are properly used when they provide an overall characterization of the general condition of the entire component being rated. Conversely, they are improperly used if they attempt to describe localized or nominally occurring instances of deterioration or disrepair. Correct assignment of a condition code must, therefore, consider both the severity of the deterioration or disrepair and the extent to which it is widespread throughout the component being rated.

The load-carrying capacity will not be used in evaluating condition items. The fact that a bridge was designed for less than current legal loads and may be posted shall have no influence upon condition ratings.

Portions of bridges that are being supported or strengthened by temporary members will be rated based on their actual condition; that is, the temporary members are not considered in the rating of the item.

Completed bridges not yet opened to traffic, if rated, shall be coded as if open to traffic.
The following general condition ratings shall be used as a guide in evaluating Items 58, 59, and 60:

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>NOT APPLICABLE</td>
</tr>
<tr>
<td>9</td>
<td>EXCELLENT CONDITION</td>
</tr>
<tr>
<td>8</td>
<td>VERY GOOD CONDITION - no problems noted.</td>
</tr>
<tr>
<td>7</td>
<td>GOOD CONDITION - some minor problems.</td>
</tr>
<tr>
<td>6</td>
<td>SATISFACTORY CONDITION - structural elements show some minor deterioration</td>
</tr>
<tr>
<td>5</td>
<td>FAIR CONDITION - all primary structural elements are sound, but may have minor section loss, cracking, spalling or scour.</td>
</tr>
<tr>
<td>4</td>
<td>POOR CONDITION - advanced section loss, deterioration, spalling or scour.</td>
</tr>
<tr>
<td>3</td>
<td>SERIOUS CONDITION - loss of section, deterioration, spalling, or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.</td>
</tr>
<tr>
<td>2</td>
<td>CRITICAL CONDITION - advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until collective action is taken.</td>
</tr>
<tr>
<td>1</td>
<td>&quot;IMMINENT&quot; FAILURE CONDITION - major deterioration or section loss present in critical structural components, or obvious vertical or horizontal movement effecting structure stability. Bridge is closed to traffic, but corrective action may put the bridge back in light service.</td>
</tr>
<tr>
<td>0</td>
<td>FAILED CONDITION - out of service beyond corrective action.</td>
</tr>
</tbody>
</table>

**Item 58 – Deck**

This item describes the overall condition rating of the deck. Rate and code the condition in accordance with the above general condition ratings. Code N for culverts and other structures without decks e.g., filled arch bridge.

Concrete decks should be inspected for cracking, scaling, spalling, leaching, chloride contamination, potholing, delamination, and full or partial depth failures. Steel grid decks should be inspected for broken welds, broken grids, section loss, and growth of filled grids from corrosion. Timber decks should be inspected for splitting, crushing, fastener failure, and deterioration from rot.

The condition of the wearing surface/protective system, joints, expansion devices, curbs, sidewalks, parapets, fascias, bridge rail, and scuppers shall not be considered in the overall deck evaluation. However, their condition should be noted on the inspection form.

Decks integral with the superstructure will be rated as a deck only and not how they may influence the superstructure rating (for example, rigid frame, slab, deckgirder or T-beam, voided slab, box girder, etc.). Similarly, the superstructure of an integral deck-type bridge will not influence the deck rating.

*Note: The New York State rating system requires the deck be rated "8" (not applicable) for structures such as frames, slabs, and those with side-by-side prestressed concrete box-beams. The Federal Rating System, on the other hand, requires a deck rating for all structures except culverts and structures with fill between the riding surface and the*
superstructure which should be coded "N" (not applicable) on the Federal Rating Form. When coding an "N" on the Federal rating Form, the type of structure should be noted (i.e.) concrete rigid frame with fill. All structures which are not culverts or do not have fill between the riding surface and the superstructure should receive a rating number for this item.

**Item 59 – Superstructure**

This item describes the physical condition of all structural members. Rate and code the condition in accordance with the previously described general condition ratings. Code N for all culverts.

The structural members should be inspected for signs of distress which may include cracking, deterioration, section loss, and malfunction and misalignment of bearings.

The condition of bearings, joints, paint system, etc. shall not be included in this rating, except in extreme situations, but should be noted on the inspection form.

On bridges where the deck is integral with the superstructure, the superstructure condition rating may be affected by the deck condition. The resultant superstructure condition rating may be lower than the deck condition rating where the girders have deteriorated or been damaged.

Fracture critical components should receive careful attention because failure could lead to collapse of a span or the bridge.

*Note: Since the New York State rating system includes miscellaneous superstructure elements such as bearings, joints, paint system, etc., the coding of these individual elements is part of the (NYSDOT) Bridge Inspection Report (BIN folder). Therefore, it is not necessary to repeat notes specific to these elements on the Federal Rating Form.*

**Item 60 – Substructure**

This item describes the physical condition of piers, abutments, piles, fenders, footings, or other components. Rate and code the condition in accordance with the previously described general condition ratings. Code N for all culverts.

All substructure elements should be inspected for visible signs of distress including evidence of cracking, section loss, settlement, misalignment, scour, collision damage, and corrosion. The rating given by Item 113 - Scour Critical Bridges, may have a significant effect on Item 60 if scour has substantially affected the overall condition of the substructure.

The substructure condition rating shall be made independent of the deck and superstructure. Integral-abutment wingwalls to the first construction or expansion joint shall be included in the evaluation. For non-integral superstructure and substructure units, the substructure shall be considered as the portion below the bearings. For structures where the substructure and superstructure are integral, the substructure shall be considered as the portion below the superstructure.
Note: Collision protection devices are considered in the determination of this item for the Federal Rating Form.

Item 113 is a Federal item. While scour is a critical situation and should be considered in the rating of a bridge substructure, the computation of Federal Item 113 is done by the Department’s Structures Division Bridge Safety Assurance Unit. However, if the Hydraulic Vulnerability Assessment report is available for the bridge, and contains a rating of 2 or less for item 113, it should be reflected in your coding of this item (no. 60).

Item No. 61 - Channel and Channel Protection

This item describes the physical conditions associated with the flow of water through the bridge such as stream stability and the condition of the channel, riprap, slope protection, or stream control devices including spur dikes. The inspector should be particularly concerned with visible signs of excessive water velocity which may affect undermining of slope protection, erosion of banks, and realignment of the stream which may result in immediate or potential problems. Accumulation of drift and debris on the superstructure and substructure should be noted on the inspection form, but not included in the condition rating.

Rate and code the condition in accordance with the previously described general condition ratings and the following descriptive codes:

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>NOT APPLICABLE - use when bridge is not over a waterway (channel).</td>
</tr>
<tr>
<td>9</td>
<td>There are no noticeable or noteworthy deficiencies which affect the condition of the channel.</td>
</tr>
<tr>
<td>8</td>
<td>Banks are protected or well vegetated. River control devices such as spur dikes and embankment protection are not required or are in a stable condition.</td>
</tr>
<tr>
<td>7</td>
<td>Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel have minor amounts of drift.</td>
</tr>
<tr>
<td>6</td>
<td>Bank is beginning to slump. River control devices and embankment protection have widespread minor damage. There is minor stream bed movement evident. Debris is restricting the waterway slightly.</td>
</tr>
<tr>
<td>5</td>
<td>Bank protection is being eroded. River control devices and/or embankment have major damage. Trees and brush restrict the channel.</td>
</tr>
<tr>
<td>4</td>
<td>Bank and embankment protection is severely undermined. River control devices have severe damage. Large deposits of debris are in the channel.</td>
</tr>
<tr>
<td>3</td>
<td>Bank protection has failed. River control devices have been destroyed. Stream bed aggradation, degradation or lateral movement has changed the channel to now threaten the bridge and/or approach roadway.</td>
</tr>
<tr>
<td>2</td>
<td>The channel has changed to the extent the bridge is near a state of collapse.</td>
</tr>
<tr>
<td>1</td>
<td>Bridge closed because of channel failure. Corrective action may put bridge back in light service.</td>
</tr>
<tr>
<td>0</td>
<td>Bridge closed because of channel failure. Replacement necessary.</td>
</tr>
</tbody>
</table>
**Item No. 62 – Culverts**

This item evaluates the alignment, settlement, joints, structural condition, scour, and other items associated with culverts. The rating code is intended to be an overall condition evaluation of the culvert. Integral wingwalls to the first construction or expansion joint shall be included in the evaluation. For a detailed discussion regarding the inspection and rating of culverts, consult Report No. FHWA-IP-86-2, *Culvert Inspection Manual*, July 1986.

Item 58 - Deck, Item 59 - Superstructure, and Item 60 - Substructure shall be coded N for all culverts.

Rate and code the condition in accordance with the previously described general condition ratings and the following descriptive codes:

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td><strong>NOT APPLICABLE</strong> - Use if structure is not a culvert</td>
</tr>
<tr>
<td>9</td>
<td>No deficiencies.</td>
</tr>
<tr>
<td>8</td>
<td>No noticeable or noteworthy deficiencies which affect the condition of the culvert. Insignificant scrape marks caused by drift.</td>
</tr>
<tr>
<td>7</td>
<td>Shrinkage cracks, light scaling, and insignificant spoiling which does not expose reinforcing steel. Insignificant damage caused by drift with no misalignment and not requiring corrective action. Some minor scouring has occurred near curtain walls, wingwalls, or pipes. Metal culverts have a smooth symmetrical curvature with superficial corrosion and no pitting.</td>
</tr>
<tr>
<td>6</td>
<td>Deterioration or initial disintegration, minor chloride contamination, cracking with some leaching, or spalls on concrete or masonry walls and slabs. Local minor scouring at curtain walls, wingwalls, or pipes. Metal culverts have a smooth curvature, non-symmetrical shape, significant corrosion or moderate pitting.</td>
</tr>
<tr>
<td>5</td>
<td>Moderate to major deterioration or disintegration, extensive cracking and leaching, or spalls on concrete or masonry walls and slabs. Minor settlement or misalignment. Noticeable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection in one section, significant corrosion or deep pitting.</td>
</tr>
<tr>
<td>4</td>
<td>Large spalls, heaving scaling, wide cracks, considerable efflorescence, or opened construction joint permitting loss of backfill. Considerable settlement or misalignment. Considerable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection throughout, extensive corrosion or deep pitting.</td>
</tr>
<tr>
<td>3</td>
<td>Any condition described in Code 4, but which is excessive in scope. Severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe scour or erosion at curtain walls, wingwalls, or pipes. Metal culverts have extreme distortion and deflection in one section, extensive corrosion, or deep pitting with scattered perforations.</td>
</tr>
<tr>
<td>CODE</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>2</td>
<td>Integral wingwalls collapsed, severe settlement of roadway due to loss of fill. Section of culvert may have failed and can no longer support embankment. Complete undermining at curtain walls and pipes. Corrective action required to maintain traffic. Metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion.</td>
</tr>
<tr>
<td>1</td>
<td>Bridge closed. Corrective action may put bridge back in light service.</td>
</tr>
<tr>
<td>0</td>
<td>Bridge closed. Replacement necessary.</td>
</tr>
</tbody>
</table>

Note: This item should be rated only if the General Type Main Span is coded "culvert" (19) in the Bridge Inventory. If the General Type Main Span is not "culvert", provide an "N". If the General Type Main Span is "culvert", give a rating for the Culvert item and rate the Deck Superstructure and Substructure items as "N".